Volume 61

American Machinist

Number 25

New York, December 18, 1924

The Design of Safe Press Fits

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Limiting values of fit stresses for various fit allowances for cast and forged steel—Definite conclusions concerning radial, tangential and combined shearing stresses

IN THE mounting of metal rings on cylinders, for example railway pinions on armature shafts, several methods are available:

A—Pressing cold ring on cold cylinder.
B—Placing hot ring on cold cylinder.
C—Pressing hot ring on slightly preheated cylinder.
D—Press fit and key.
E—Shrink fit and key.

Both radial and tangential stresses are set up in the ring when either pressed or shrunk upon the cylinder. Hence, if a pinion is shrunk or pressed on an armature shaft it will require a considerable tangential force at the pitch circle to turn the pinion relative to the shaft. It has been found that a shrunk fit is stronger than a pressed fit, all other things being equal, because of the path cut on the surface of the shaft when the pinion is pressed on and because of the lubricant used for such fits. With the use of keys, neither of the two fits need be as strong as without, but, in the case of pinions, keyways are a source of weakness and their cutting adds to the expense of production.

Limiting Values of the Safe Stresses for Various Fit Allowances of Cast-Steel and Forged-Steel Fits

Range of $\frac{R_b}{R_o} = \frac{1}{4}$ to $\frac{3}{4}$

Fit Allowance in Inches	Combined Shear Stress in Lb. per Sq. In.	Radial Stress in Lb. per Sq. In. Min.	Radial Stress in Lb. per Sq. In. Max.	Tangential Stress, Lb. per Sq. In. Min.	Tangential Stress, Lb. per Sq. In. Max.
0.00075	11,250	4,000	10,500	12,000	18,000
0.001	15,000	6,500	14,000	16,000	23,500
0.002	30,000	13,000	28,000	32,000	47,000

The formulas used in the design of fits are not easily available nor are they presented in the most simplified form. The following information outlines a method in which the work of calculation is greatly reduced. Press fits under normal temperature only are considered, since the design of shrink fits reduces to that of the former when the fit allowance, due to shrinkage, is predetermined from the coefficient of expansion for the material in question and from the bore size. Keyed fits likewise will not be considered.

In addition to considering press fits from the standpoint of safe stressing, the capacity for resisting tangential effort will be considered. The importance of safe stressing is emphasized, since it has been shown by P. Heyman, G. R. Brophy and A. L. Kimball, in a most striking manner, using the photoelastic method, that the magnitude of the radial stress has a marked effect on pinion-tooth failures.

Press Fit Stresses

A—Assumptions:

1—*Stresses.* The following safe maximum stresses are assumed:

1.1—Forged Steel (both in tension and compression)
Maximum hardness.....35,000 lb. per sq.in.
Minimum hardness.....25,000 " " "

1.2—Cast Steel (both in tension and compression)
Maximum hardness.....25,000 lb. per sq.in.
Minimum hardness.....15,000 " " "

1.3—Cast Iron (unchilled portion)
Tension (tangential).... 8,000 lb. per sq.in.
Compression (radial)....15,000 " " "

2—*Formulas.* The formulas developed by Stodola are assumed, these being as follows:

2.1—Radial stress, $S_R = \frac{\Delta}{d_b} E \frac{(a^2-1)}{2}$

2.2—Tangential stress, $S_T = \frac{\Delta}{d_b} E \frac{(a^2+1)}{2}$

The following formula is also assumed:

2.3—Combined shear stress,

$$S_s = \frac{\text{radial stress} + \text{tangential stress},}{2}$$

where Δ = total fit allowance for bore, d_b;
d_b = bore diameter. (See Fig. 1).
E = tensile modulus of elasticity = 30×10^6 for all materials listed above, except cast iron, which has 15×10^6.
a = ratio of bore diameter, d_b, to outside metal diameter, d_o.

Other assumptions are that the hub and shaft are of similar material and that the shaft is solid.

B—THEORY:

$$S_R = \frac{\Delta}{d_b} E \frac{(a^2-1)}{2} = \frac{\Delta}{d_b} \frac{E}{2} \left[\frac{(d_b)^2}{d_o} - 1 \right]. \quad (1)$$

Inasmuch as d_b is always smaller than d_o this formula will always give a negative value for S_R, which

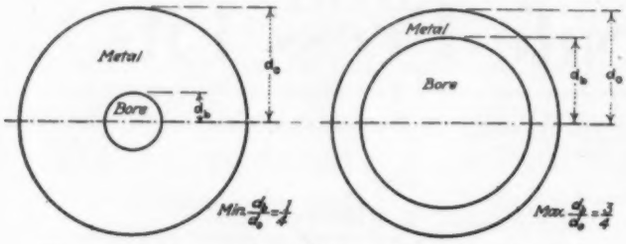

Fig. 1—Diagram illustrating formula given in paragraph 2.3

simply means that the wrong direction has been assumed for this stress in the derivation of the formula. We, therefore, may rewrite this formula as follows:

$$S_R = \frac{\Delta}{d_b} E \frac{(1-a^2)}{2}. \quad (2)$$

Now to obtain an expression for the combined shearing stress S_s we proceed as follows:

$$S_s = \frac{S_R + S_T}{2} = \frac{1}{2} \left[\frac{\Delta}{d_b} E \frac{(1-a^2)}{2} + \frac{\Delta}{d_b} E \frac{(1+a^2)}{2} \right]. \quad (3)$$

$$S_s = \frac{\Delta E}{2 d_b} \left(\frac{1-a^2+1+a^2}{2} \right),$$

$$= \frac{\Delta E}{2 d_b} = 15 \times 10^6 \frac{\Delta}{d_b}, \text{ or } = 7.5 \times 10^6 \frac{\Delta}{d_b} \text{ for cast iron} \quad (4)$$

which shows that, contrary to the general understanding, the combined shearing stress S_s does not necessarily have to be calculated from the radial and tangential stresses, but can be determined directly from a very simple relation, namely, that, "The combined shearing stress S_s is equal to one-half the fit allowance per inch of bore diameter, multiplied by the tensile modulus of elasticity."

C—PARTICULAR CASES:

1—*Fit allowance of 0.001 in. per in. of bore diameter.*

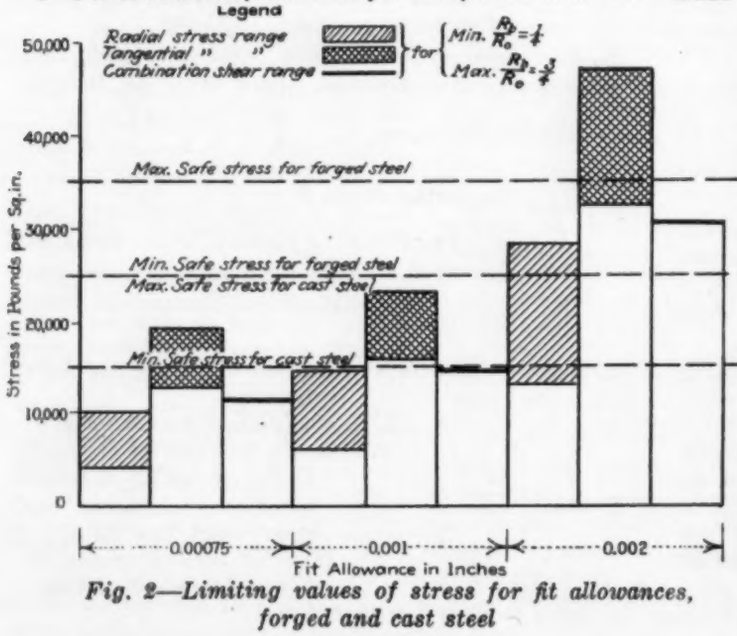

Fig. 2—Limiting values of stress for fit allowances, forged and cast steel

Although this allowance is not generally specified for fits, yet it is universally the practice to use it in the design calculations.

1.1—Combined Shearing Stress.

$$S_s = 15 \times 10 \times 0.001$$

$$= 15{,}000 \text{ lb. per sq.in.}$$

In this case the shearing stress need not be calculated as it remains constant and is independent of the amount of metal in the hub or web.

It also follows that inasmuch as the equivalent maximum allowable stress in shear is equal to about 60 to 75 per cent of the maximum allowable stress in tension and compression, press fits should not be employed in the case of cast iron and partially hardened cast steel. Shrink fits, keys, or a smaller fit allowance, say about 0.00075 in. per inch of bore diameter, should be employed instead.

1.2—Radial Stress.

$$S_R = \frac{\Delta E}{d_b} \frac{(1-a^2)}{2} = \frac{0.001 \times 30 \times 10^6}{2} (1-a^2).$$

$$S_R = 15{,}000 (1-a^2) = 15{,}000 \left[1 - \left(\frac{d_b}{d_o} \right)^2 \right].$$

It therefore follows, that for the materials and fit allowance assumed, the radial stress for press fits need not be calculated, because it cannot be greater than a safe value, no matter how much metal exists in the web or hub.

1.3—Tangential Stress.

$$S_T = \frac{\Delta E}{d_b} \frac{(1+a^2)}{2} = \frac{0.001 \times 30 \times 10^6}{2} (1+a^2)$$

$$= 15{,}000 (1+a^2)$$

$$\text{also, } S_T = 2S_s - S_R = 2 \times 15{,}000 - 15{,}000 (1-a^2)$$

$$= 30{,}000 - 15{,}000 (1-a^2)$$

$$= 15{,}000 (1+a^2) = 15{,}000 \left[1 + \left(\frac{d_b}{d_o} \right)^2 \right].$$

The nature of this stress is tension and the maximum value it can have according to the formula and assumptions made is 30,000 lb. per sq.in., no matter how little metal exists in the hub or web. The minimum tangential stress is 15,000 lb. per sq.in. for forged and cast steel and 7,500 lb. per sq.in. for cast iron. In Fig. 2 these limiting values are shown diagramatically.

Since the tangential stress cannot be less than 7,500 lb. per sq.in., it is apparent that press fits cannot be made very safely with cast iron, in so far as this particular type of stress is concerned. However, as this minimum stress is obtained with maximum metal, it probably would not be objectionable to exceed the elastic limit of the metal in tension (tangential) and depend upon the radial stress, which is a maximum in this case, along with sufficient length to maintain an adequate fit.

This practice is an exception to the general rule of not exceeding the elastic limit and should not be followed unless absolutely necessary. All things being equal, fits made under these conditions are inferior to those not made under them. Shrink fits, or smaller allowance per inch of bore diameter, should be resorted to instead of the method outlined.

The above holds true for cast steel of minimum hardness, except to a smaller extent, because maximum safe allowable stress for this material is just equal to the minimum value the tangential stress in a fit may have according to the formula. As the metal approaches zero thickness, the elastic limit of this material is more and more exceeded.

Now the maximum value of 30,000 lb. per sq.in. that the tangential stress will have, according to the formula, is obtained with very thin metal, approximating hoops. In connection with the subject of press fits (car wheels, drivers, crankpins, gears, etc.), which we are discussing, the metal thickness is usually quite large in comparison with the bore. Consequently, in practice the maximum working tangential stress is considerably less than 30,000 lb. per sq.in. The limiting values of the ratio between metal and bore for the other materials are as follows:

$$\frac{\text{Metal}}{\text{Bore}} = \frac{R_o - R_b}{2R_b} = \frac{1}{2}\left(\frac{R_o}{R_b} - 1\right) = \frac{1}{2}\left(\frac{1}{a} - 1\right).$$

For cast steel of maximum hardness ($S = 25{,}000$ lb. per sq.in.) and forged steel of minimum hardness ($S = 25{,}000$ lb. per sq.in.),

$$\text{Ratio} = \frac{1}{2}\left(\frac{1}{a} - 1\right)$$

$$S_T = 15{,}000\ (1 + a^2)$$

$$a^2 = \frac{S_T - 15{,}000}{15{,}000} = \frac{25{,}000 - 15{,}000}{15{,}000} = \frac{2}{3}$$

$$\text{or } a = \sqrt{\frac{2}{3}}$$

$$\therefore \text{ratio} = \frac{1}{2}\left(\frac{1}{\sqrt{\frac{2}{3}}} - 1\right) = 0.11.$$

That is, the required metal equals 11 per cent of the bore, which is considerably less than would naturally occur in practice.

For forged steel of maximum hardness ($S = 35{,}000$) the fit is always safe, as the maximum tangential stress is 30,000 lb. per square inch.

Therefore, we may say that for the materials considered and the assumptions made, the tangential stress need never be calculated for forged steel and for cast steel of maximum hardness.

Radial Force

Although it was pointed out above that the radial stress need not be calculated from the safe stressing standpoint, it may be necessary to calculate it in order to determine the total resistance available in the fit as regards the tangential effort being transmitted.

$$S_R = 15{,}000\,(1 - a^2).$$

Total Radial Force per inch of length equals F_R

$$= 15{,}000 \times \frac{22}{7} R_b \left[1 - \left(\frac{R_b}{R_o}\right)^2\right]$$

$$= 47{,}200 \left(\frac{R_b R_o^2 - R_b^3}{R_o^2}\right)$$

$$\text{Maximum } F_R = 47{,}200 R_b.$$

Now, although the above formula indicates that the minimum radial force or holding power of the fit is zero, it must be remembered that the tangential stress is also available as holding power, as may be witnessed by the hoops on guns or barrels. This force is equal to 2 × metal thickness × S_T.

However, in the usual press fit the ratio of metal thickness $\frac{(R_o - R_b)}{2}$ to bore diameter is great enough to eliminate the hoop effect easily; that is, tangential stress decreases very rapidly in value from the bore to the outside surface of the web or hub for the ratios $R_b \div R_o$, which usually occurs in practice (Stodola) so that the maximum value stated for F_R above is sufficiently accurate.

For the full length L of the fit the total radial force equals

$$F_R = 47{,}200 R_b \times L.$$

The total tangential resistance is equal to

$$F_T = F_R \times \text{coeff. of friction } \lambda,$$

in which the value of λ may vary widely, depending upon the surface finish and whether or not lubrication is used.

Assuming $\lambda = 0.3$, the maximum tangential resistance which a fit can exert is

$$F_T = 47{,}200 R_b L \times 0.3 = 14{,}160 R_b L.$$

As an example, suppose that the bore $R_b = 5$ in. and the length of fit $L = 10$ in., then the maximum $F_T = 708{,}000$ lb. or 354 tons.

Of course this limiting value does not apply to practice since the metal thickness is proportionally very much less. Assuming that the metal thickness is 50 per cent of the bore diameter, then the tangential resistance equals 75 per cent of the possible maximum resistance. In the above numerical example the tonnage existing in the fit would be equal to

$$354 \times \tfrac{3}{4} = 265 \text{ tons.}$$

Torque

The torque exerted by the tangential force F_s, which may be a load at pitch line, must be resisted by the fit tangential force, F_T.

$$F_T \times \frac{R_b}{2} = F_s R_s$$

$$\text{or} \quad F_T = 2\,\frac{F_s R_s}{R_b}.$$

For a safe fit a factor of safety of at least 5 should be used, which gives

$$F_T = 10 F_s \frac{R_s}{R_b}.$$

Under these conditions the maximum torque which can be transmitted ($\lambda = 0.3$) is

$$F_s R_s = \frac{F_T}{10} R_b = 14{,}160 R_b^2 L,$$

which for the example above ($R_b = 5''$ and $L = 10''$)

$$= \frac{708{,}000}{10} \times 5 = 354{,}000 \text{ in.-lb.}$$

Fit Allowances Smaller and Greater Than 0.001 Inch

The article so far has considered an allowance of 0.001 in. per in. of bore diameter. Small allowances give proportionally small radial, tangential and shear stress, but also less adequate fits. Larger fit allowances give proportionally larger radial, tangential and shear stresses. The limiting values of the safe stresses for various fit allowances of cast steel and forged steel fits are given in the table and shown in Fig. 2 diagrammatically.

Conclusions

1—The limiting values of the fit stresses are shown for various fit allowances of cast steel and forged steel fits in the attached table and curve.

2—For a fit allowance of 0.001 in. per in. of diameter the following statements hold true for cast iron, cast steel and forged steel solid shafts and hubs:

2.1—The combined shearing stress has a constant value of 15,000 lb. per sq.in., hence it is not necessary to calculate this stress from the radial and tangential stresses. All materials except cast

iron can be used safely under this stress. A smaller fit allowance should be used for cast iron.

2.2—The radial stress cannot be greater than 15,000 lb. per sq.in. and all of the materials considered can be used with safety under this stress.

2.3—The tangential stress varies between 15,000 and 30,000 lb. per sq.in. Provided the thickness of metal is equal to 11 per cent of the bore, or more, forged steel and properly hardened cast steel may be safely used.

Book Reviews

Taking the Guesswork Out of Business. By William R. Basset, Chairman of the Board, Miller, Franklin, Basset & Co., Inc. One hundred seventy-nine pages, 5x7 in., cloth. Published by the B. C. Forbes Publishing Co., 120 Fifth Ave., New York City. Price $2.

Here is a book that, once begun, will be read from cover to cover. It is a plea and a guide for the application of common sense to business and the treatment is broad enough to fit all industry.

Mr. Basset points to scientific planning as the means of taking the guesswork out of business. In developing his theme he treats of analyzing the product, the benefits of concentration, selling, buying, finance, advertising, credit policies, personnel relations, production costs, and prices.

As a piece of writing the book is good, and interest is added by the use of the case method in presentation. The examples, of course, illustrate economies effected, increases in business, and similar accomplishments. The simplicity of the changes made and the programs followed make the results more than commonly striking.

Scientific Managements Since Taylor. A collection of authoritative papers edited by Edward Eyre Hunt, Assistant to the Secretary of Commerce. 263 pages, 6 x 9 in. Bound in cloth. Published by McGraw-Hill Book Co., Inc., New York. Price $3.

Mr. Hunt's compilation of articles on various phases of scientific management draws from the files of such periodicals as the *Bulletin of the Taylor Society, Industrial Management* and the *Harvard Business Review*. As is to be expected some of the selections are excellent, others are mediocre. Some of them are marred by careless proofreading and by slovenly English.

The book is divided into four parts of which the first is concerned with the nature and achievements of scientific management. All possible tribute is given by the authors to the fundamental work of Frederick W. Taylor in the management field, in some instances more than Taylor himself would have felt justified. Fortunately one of the authors seems to have been familiar with Taylor's shortcomings and comments on their effect on his followers and their work.

Part II is headed "Scientific Management in General Management." It contains the most practically valuable chapters of the book. The unemployment problem is attacked in Part III, the feature chapter being an excerpt from a speech by Secretary Hoover on industrial standardization.

The final section, under the heading "Ownership, Management and Workers," turns to the personnel problem. Probably the most interesting reading in the whole book is to be found in these chapters, particularly in the ones by Edward A. Filene whose subject is "Why Men Strike," and by the late Robert G. Valentine on "The Progressive Relation between Efficiency and Consent."

Mr. Hunt contributes an introduction to each of the four parts outlining the ground to be covered. There is a foreword by Morris L. Cooke.

Effective Industrial Advertising. By Keith J. Evans Forty-eight pages, 5x8 in., paper covers. Illustrated. Published by G. D. Crain, Jr., 537 S. Dearborn St., Chicago, Ill.

Mr. Evans, who is the advertising manager for Joseph T. Ryerson & Son, Inc., Chicago, has written a series of articles touching upon the important activities of the advertising and sales promotion department in the industrial field. The articles have been condensed to essentials and make very interesting reading for all executives and particularly for those governing advertising. The subject is treated in six chapters with the following headings:

Product and Market Analysis plan; Functions of Advertising Department; Mediums of Advertising Department; How Best to Use Business Papers; Mail "Conversation" Gets Prospects Inquiries; How Advertising Can Co-operate with Sales.

Mr. Evans uses actual advertisements as illustrations and has also discussed various advertising mediums, how best to work with the editorial department of publications, results of discussions on ads, and other topics of more than passing interest to the advertising man.

Manchuria, Land of Opportunity. Ninety-eight pages, 6x9 in., board covers. Illustrated. Published by the South Manchuria Railway, 111 Broadway, New York City.

Just what may be expected in this part of the world from an industrial standpoint is well outlined in the book that has been published recently. The work that has been done by the South Manchuria Railway in blazing a trail into the rich agricultural parts of the country since the Russian-Japanese War and the industries that have been built up along the lines of the railways are detailed into a story of pioneer romance.

Many modernly built hotels and public buildings have been erected within the past few years. The railway itself is using locomotives and freight cars made in the United States and from the illustrations there is but little difference noted from railroad trains in the United States. The repair shops use modern American machine tools and some of the heavier machinery used in the Manchurian steel mills is also from this country.

An excellent map in the back of the book shows Korea, Manchuria and part of Mongolia. It has railway lines indicated as well as the roads built for automobile travel.

Among the papers recently published by the Department of Commerce, Washington, D. C., are the annual report of the Bureau of Standards for the fiscal year ended June 30, 1924 designated as M 60 and two papers on simplified practice recommendations designated as R 16, Lumber, and R 17, Forged Tools. These publications may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The paper on lumber is fifteen cents and the forged tool paper is five cents.

Methods of Machine Tool Design

By A. L. DeLeeuw
Consulting Editor, *American Machinist*

Problems in the design of guides for machine tools—Lathe bed construction and proportions—General rules for lathe design changed by operation requirements

GENERALLY speaking, the movements of the main parts of a machine tool are either motions of rotation or translation. For the present we will confine ourselves to this latter class, as the means for controlling the motions of rotation will be taken up when dealing with spindles. To guide a member in a rectilinear path seems very simple, and so it would be if it were not for the fact that in a machine tool there

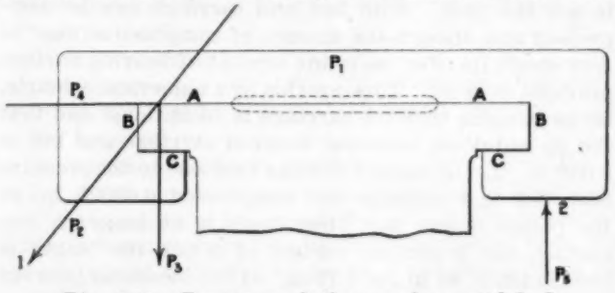

Fig. 247—Forces on lathe carriage and bed

must be, practically speaking, no lost motion or deviation from the desired path. To guide a member in a straight line merely requires two surfaces that are perfectly straight and flat. Perfection, of course, cannot be reached and in most types of machinery there is some quite permissible deviation from this perfection.

This is not so in machine tools, and the tolerances are very small. Besides, even if it were possible to make the guiding surfaces perfect, they would soon lose this perfection and we would have the same condition as if the surfaces had been imperfect from the start. Machine-tool guiding surfaces must be made as nearly perfect as possible and must be so constructed that loss of alignment due to wear can be corrected. To examine this problem somewhat closer, assume that in Fig. 247 we have a section of a lathe carriage sliding over a bed. As may be seen, the bed is represented here with a flat top extending all the way across and the carriage is constructed so that it hugs the bed top, bottom, and sides.

The objectionable features of this construction are many. In the first place, by using the entire top of the bed as a supporting surface it becomes necessary to make this surface very nearly perfect. However, this would not be necessary at all for the purpose of supporting the weight or pressure of the carriage on the bed, so that the first thing to do is to reduce this flat surface by recessing it as shown by the dotted lines. We may also recess the carriage correspondingly. Having a fair knowledge of the maximum pressure which will come on the carriage and knowing its length, it will be a simple matter to calculate the amount of flat surface required. The question of how to divide up this flat surface between the front and the rear of the bed now remains. If the weight of the carriage is P_1 and the pressure of the tool in the direction of arrow *1* is P_2, it is necessary to find the point where this arrow intersects the bed, and at this point the vertical component of P_2 acts. Therefore, the front surface must support half of P_1 and all of P_2.

However, such a simple condition as the one assumed exists only when the machine is built for one single job. A lathe of the commercial type, which has to take care of all kinds of jobs, may have the line P_2 in various directions and the force P_2 may be of various magnitudes. The arrow *1* would not always intersect the top of the bed at the same point. In order to find what should be done about the surfaces of the bed, we must assume extreme conditions and, as far as the front

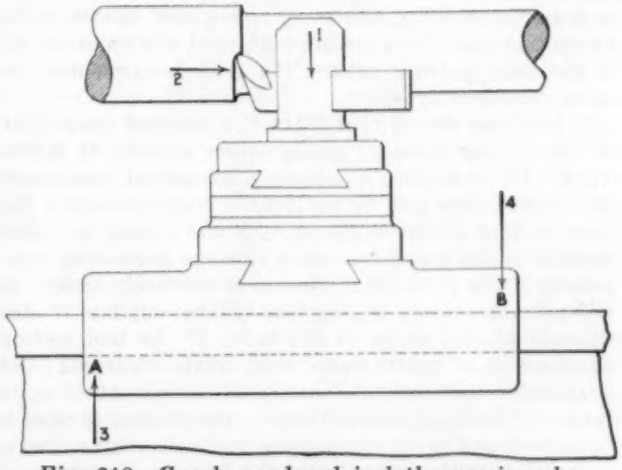

Fig. 248—Couple produced in lathe carriage by longitudinal feed

bearing of the bed is concerned, these extreme conditions exist when the work is of maximum diameter and when the cut is also a maximum.

The rear bearing of the bed might be made very small if the lathe always turned in one direction, because in that case no part of the pressure of the cut comes on the rear bearing. Without considering a number of practical details which will be mentioned later, we might say that the rear bearing need be only large enough to support half the weight of the carriage.

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If there is a rear tool-slide with an inverted tool, there is a downward pressure on the work at the point of this tool and, consequently, an upward reaction on the tool. In this case there is a pressure P_s as the vertical component of this reaction. If the rotation of the spindle is reversible so that the rear tool can take a cut in the same manner as the front tool, the rear bearing should have the same surface as the front bearing. As a rule, when such a condition—that is, of the reversible spindle movement—exists, the cuts taken are not very heavy, being used for threading or other light operations.

However, there are conditions where the rear cut may be heavier than the front cut. Such a condition may exist in screw machines which, after all, are simply modified lathes. For that matter, an ordinary lathe may be rigged up for such work, as for turning and

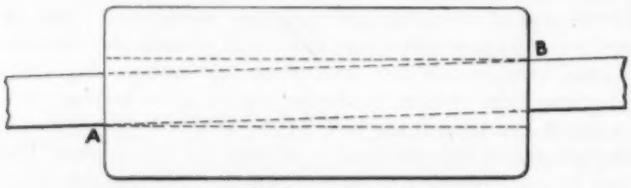


Fig. 249—Diagram showing effect of looseness in guides

forming pulleys or other shaped work. It may be desirable to do the roughing cut with the rear tool so as to have a better view of the front one. In that case the movement of the spindle should be such that the forming cut lifts the tool away from the lathe and, therefore, the roughing cut coming on the rear tool would bring its pressure to bear on the rear bearing.

All in all, a lathe bearing must be ready for almost any combination of conditions, so that it is usually wise to make the rear bearing not much narrower than the front one. When a machine is built for special purposes such as, for instance, the heavy lathes used in steel mills where there may be a certain variety of work and yet all of the same general nature, the front bearing may be made considerably wider.

It has been shown that there is a vertical component of the cutting pressure acting either upward or downward. There is also, of course, a horizontal component and its direction may be toward the front or toward the rear, so that all the surfaces *A*, *B* and *C* may be called upon to resist pressure. As a rule the horizontal component of the pressure of the cut is relatively small. It depends, of course, on the size of the cut, but it also depends on the shape of the tool. If the tool section approaches a right angle with little clearance and practically no rake, the horizontal component is quite large. It becomes less and less as the amount of rake is increased, and there may come a point where the rake is so great that the direction of the horizontal component is reversed, the tool being pulled in instead of being pushed back.

So far only the nature of the forces at work in a plane at right angles to the axis of the lathe have been considered, and we have found that all of the surfaces shown in Fig. 247 are necessary at one time or another to resist the pressures caused by the cut. It is but seldom that cuts in which all the forces act in that one plane are taken. Such cuts are those for cutting off or necking material. When a cut is taken with a feed in the direction of the axis of the lathe additional stresses will be found in a plane parallel to the axis. These are due to the feed. In Fig. 248 arrow *1* represents the pressure against the tool in a plane at right angles to the axis, and arrow *2* indicates the reaction in a plane parallel to the axis. The pressure against the tool takes place at or very near the horizontal center plane of the lathe, so that the reaction *2* has a tendency to tip the carriage backward or, in other words, it causes a couple. Besides its effect on the carriage itself, this couple also brings unequal pressure to bear on the lower and upper surfaces of the bed. For instances, it will bring additional pressure to bear on the lower surface, as indicated by arrow *3* at point *A*, and additional pressure on the upper surface as indicated by arrow *4* at point *B*. So long as the carriage has a good fit on the bed, the amount of the tipping movement is necessarily limited, but as soon as this fit is less perfect, the result of the tipping force will be to lessen the amount of resisting surface materially. This is shown in Fig. 249 in exaggerated form.

If the material of both bed and carriage were perfectly hard, in other words, if it were not possible by any means whatever to make any impression on the materials, there would be only a line contact between carriage and bed at the points *A* and *B*. Such, of course, is not the case. Both bed and carriage can be compressed and, though the amount of compression may be very small, its effect as to the amount of bearing surface provided is great. To show this by a numerical example, let us imagine that the carriage is 30 in. long, and that the up-and-down looseness between carriage and bed is 0.002 in. Let us assume further that due to the pressure both bed and carriage are compressed 0.00025 in. at the points *B* and *A*. Then there is no longer a line contact, but a surface contact of which the length is one-eighth of 30 in., or 3.75 in. If the looseness between

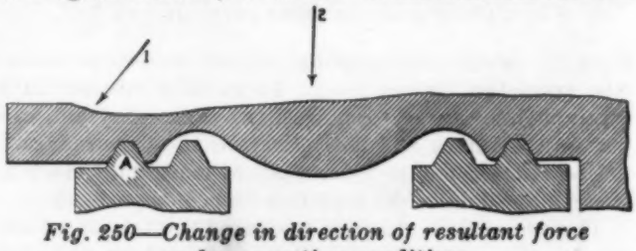


Fig. 250—Change in direction of resultant force under operating conditions

carriage and bed had been 0.001 instead of 0.002 in., the length of this contact would have been 7½ in. If it had been only 0.0005 in., the length of contact would have been 15 in. We see, then, that the pressure per sq.in. and, therefore, the distortion and wear of both bed and carriage depend very largely on the amount of looseness between carriage and bed, and that conditions become rapidly worse with additional looseness.

The effect of the looseness of machine tool parts is not always fully realized. It is commonly thought that looseness is objectionable because it affects the accuracy of the work and that, when no accuracy is required, some looseness does no great harm. It is perfectly true that looseness affects the accuracy, but it is equally true that it affects the wear of the machine. Where a machine is used for inaccurate work, say for roughing, it is generally subjected to heavy stresses and it is of great importance that there should be a large area of contact between the moving parts, so as not to have too great a pressure per unit of surface. This amount of surface contact can be increased by keeping the looseness between the parts to a minimum,

and for this reason it is advisable to keep a minimum of lost motion on a lathe, regardless of whether it is called upon to do accurate work or merely roughing.

The total resultant of all the forces at work is not a single force but a force and a couple. In other words, there are forces at work tending to compress or to bend and also to twist the bed. The exact amount of these forces or couples cannot be predetermined because it depends on the nature of the work and also on the nature of the tool. We have seen that there is a possibility that the tool may be pushed or pulled in a plane at right angles to the axis, this action depending on the angles of the tool and, to a certain extent, on the nature of the material to be cut. The feed may also have a similar effect, that is, the tool may be pulled in in the direction of the feed or it may be pushed back. It is very seldom that this pulling in takes place, because the angle of the tool would have to be so small that it probably would not resist the pressure on it. In other words, it would break down under the cut. Yet there are cases where such pulling in may occur.

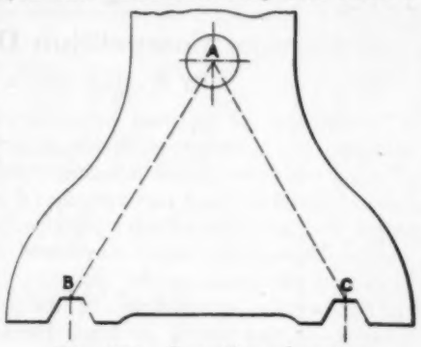


Fig. 251—Location of center and Vees

A carriage and bed are shown in Fig. 250 in diagrammatic form, the carriage being supported on Vees. The resultant is indicated by arrow *1* and under these conditions there would be a tendency to pivot the carriage around the point *A*. If the work had been smaller and the shape of the tool perhaps somewhat different, this resultant might have been arrow *2*, in which case the effect would be a strong tendency to bend the carriage.

All of the foregoing shows that the operating condition in a lathe may be so many and so varied that there is only one safe method to follow in designing a lathe bed. It must be given the greatest possible strength and the greatest amount of wearing surface compatible with practical considerations, such as cost, weight, floor space, etc. The thing to do is to work toward an ideal and this ideal would be a box-shaped bed casting of great width and depth, and with large bearing surfaces. Considerations of a different kind will necessarily limit the dimensions but the designer should always keep before him the idea that there is no harm done when the surfaces are too large or the casting stronger than is necessary. Every time he finds that it is necessary to reduce bearing surface areas for some practical reason he should cautiously inquire as to whether this reason really exists or whether it is merely the result of a misconception. If it does exist, he must determine to what extent the size of the casting or its bearing surfaces must be reduced. The reduction should be kept down to a minimum.

Various general rules have been developed in the past and have come to be accepted as axioms in the design of a lathe. These rules have the advantage of focusing the eye of the designer on something definite. On the other hand, they have the disadvantage of making him think that he is relieved of the necessity of analyzing his problem. For instance, there is a rule that, for a lathe in which the headstock is placed on Vees, the lines between the center of the spindle and the centers of the Vees should form an equilateral triangle. Consequently, the average man has come to think that, when the angle *BAC*, Fig. 251, is less or more than 60 deg., something most be wrong. After all, this is merely a compromise. If only one thing at a time were considered, we would obtain different sizes and angles in the triangle formed between the spindle and the Vees. For instance, it is well to keep the height of the spindle down to a minimum so as to reduce the leverage on the headstock, but then we may not have enough room to build up a substantial carriage, tool slide, and tool post. So, in order to get these parts of ample dimensions, the center of the spindle should be high. Of course we can accommodate both requirements by making the spindle high and the distance between the Vees large, but then we merely have a lathe of larger size.

The equilateral triangle is a very good compromise for most commercial machines. However, as soon as definite requirements for the machines are known, we should no longer be satisfied with this compromise, but should analyze the conditions and make the proportions to correspond. If, for instance, a lathe is made to turn up pulleys of large size—a machine in which the tool never needs to approach the center—we would be justified in locating the headstock center low. Not only that, but there would be no reason why the carriage needs to extend from front to rear. Fig. 252 illustrates a construction that might be used.

Another well-known rule in designing a lathe is that the length of carriage should be about one and one-half times the swing. Again, this is not a bad rule to remember, provided it is not applied without carefully considering the requirements of each individual case. If, for instance, a lathe is designed to do heavy work on shafts alone, so that the swing can be quite small, this rule would not apply at all. The carriage would be too short. On the other hand, if a lathe were designed to do light work on the rims of pulleys of large diameter, a carriage based on this rule would be entirely too long. Still another rule is that the width of the cross-slide should be practically one-half the swing. Rules like these are good starting points, but should never control the design.

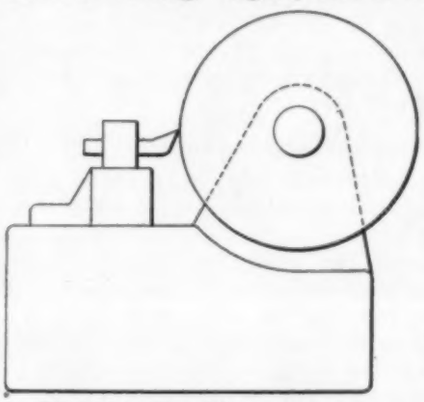


Fig. 252—Special arrangement for turning pulleys

In these articles no attempt is being made at giving the solution for any particular set of conditions. If the designer knows the forces acting on a lathe bed, he is confronted with the same kind of problem that any designer meets when he has to design a casting of given strength and rigidity. Formulas and rules to help him can be found in various works on machine design in general or on the strength of materials. In these articles problems will be pointed out rather than solved.

A Progressive Equipment Buyer —Discussion

By D. C. Wright

THE remarks of Frederick Franz, page 392 Vol. 61, of *American Machinist*, relative to a previous article upon the above subject and his request—seconded by the editor— for comment, prompts me briefly to set forth my attitude in the matter. This may or may not be of material value to the discussion, but it may be considered at least, as another point of view.

Such a question, in the writer's estimation, is one that should not be settled in any factory by arbitrary rule. Even in a plant as thoroughly standardized in the matter of production as is that of Mr. Ford, the conditions surrounding any one particular operation and its equipment are such as to make it necessaray to judge of its economies in a different way, or at least, upon a different scale, from those involved in other operations.

Any rule that may be adopted is bound to be of the nature of an average, chiefly valuable in arriving at decisions by cutting through "red tape" and relying upon the time thus saved to offset whatever error there may be in direct application of the rule. Therefore, the manufacturer alluded to in the Editor's comment who establishes the two year limit, though certainly reaping a big return from whatever tools or manufacturing innovations he may adopt upon this basis, must inevitably miss a much larger ultimate profit.

Neither can I agree with Mr. Franz when he states that a capital investment is not justified in the event that a piece of equipment is junked immediately after it has earned its cost. In taking such an attitude only one of the two factors in equipment values is considered; namely, unit cost. The other factor, output per unit of time, is overlooked entirely.

Unit Costs and Salable Output

In other words, while the ability to produce twice as much of a certain unit per year with a given investment of labor might lower the cost per unit to a point where the savings on the output over a given time period would equal the cost of the new equipment, it should not be forgotten that the mere increase in the quantity of salable output has a distinct value in many cases, even though the unit cost had not been affected.

Also, in the final analysis, is the investment of capital in new equipment actuated by motives in any way different from those impelling investment in stocks, bonds or savings accounts?

We have no hesitancy in branding as "wildcat" such financial propositions as propose to pay more than a certain rate of interest; and an investment of this type seldom pays more than 10 per cent, while real safe, conservative "gilt edged" investments usually return less. Why, then, should an investment in machinery be expected to pay 50 per cent or better in order to justify itself?

Admitting that the trend of mechanical development is constantly toward greater economies, and that a machine tool of a certain degree of efficiency today may be placed in the background next year by another machine of twice its efficiency, at the same time it should be borne in mind that within the limits of physical deterioration there is a saving being effected over previous processes.

Therefore, if the plant has a proper system for depreciating their machine values that will automatically absorb the capital investment within a reasonable time, any return derived from increased machine efficiency is a profit.

Whether or not that profit is large enough to justify the retention of equipment after something better has been placed upon the market is entirely—or at least very largely—a matter to be decided strictly upon a basis of local conditions.

And this doesn't mean for any plant as a whole, but as nearly as possible the conditions surrounding the particular operations or groups of operations directly affected by the proposed change.

Is German Competition Dangerous?

By W. H. Rastall

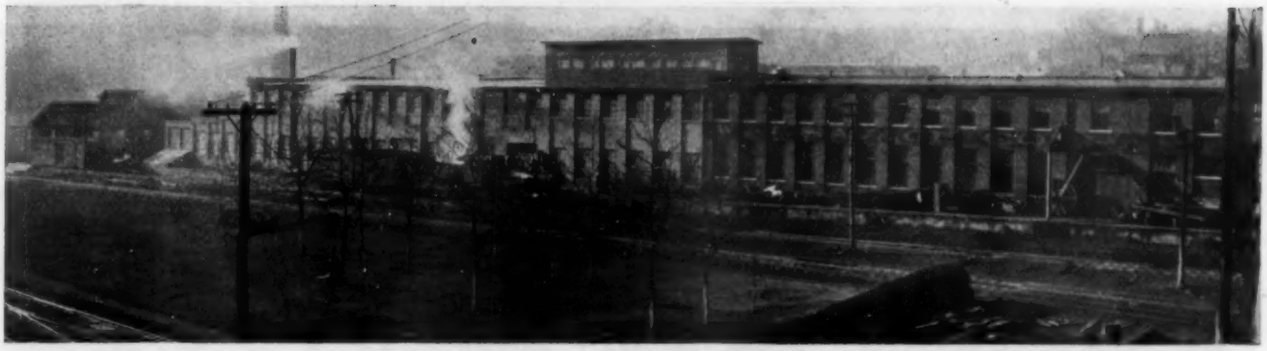
The picture of German competition in the minds of some of our more conservative exporters has been one of an irresistible force flooding foreign markets with goods offered at very low prices and long terms of payment, giving extraordinary service, interlocking banking facilities with highly developed selling methods so that the American works under a hopeless handicap, and generally succeeding in keeping the principal markets of the world, in some lines at least, entirely in German hands. Some critics believe the American exporter a mere novice, ignorant of the first principles of foreign trade, enjoying brief advantages perhaps due to conditions brought about by the war, but soon to withdraw from business abroad in favor of other more experienced nationals. The inaccuracy of such a description is clearly indicated by the experience in the machinery market of Italy, a field in which German interests have been thought to be especially strong.

The machinery market of Italy is one that might be termed peculiarly susceptible to commercial domination by Germany, because of propinquity, close acquaintance, depreciated German exchange, and other factors working hand in hand with the German salesman. An article in the Industrial Machinery section of a recent issue of *Commerce Reports* shows that the low exchange countries, such as Germany and Austria, have not been able to maintain the position they had held.

A further significant fact is brought out, namely, that countries with stable currencies, such as Great Britain and the United States, have shown striking increases in machinery sales in Italy. Great Britain has been able to more than double the volume of business done two years ago, while sales of American machinery have practically quadrupled since 1921. This, in a highly competitive market, with many factors, such as distance, working to our distinct disadvantage, American machinery, always in keen competition with British as well as German equipment, leads the market from the standpoint of growth. The conditions brought out by the Italian situation are also significant in providing an index of the competing ability of German manufacturers.

American goods and American selling methods are able to compete favorably abroad, and it is time to lose our diffidence and awake to advantages made possible by the lessening of competition from low-exchange countries.

From *Commerce Reports*.

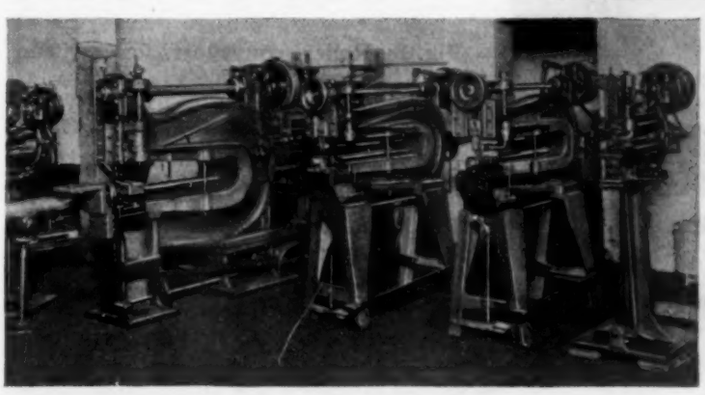


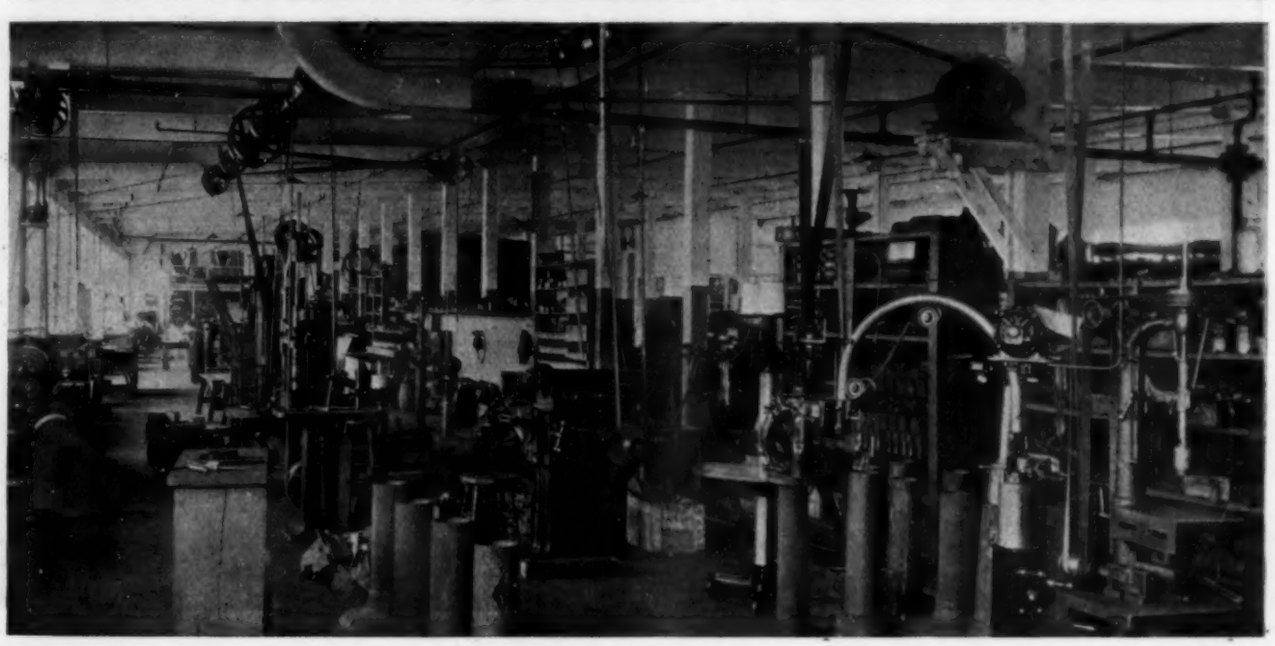
Where Machine Tools Are Made

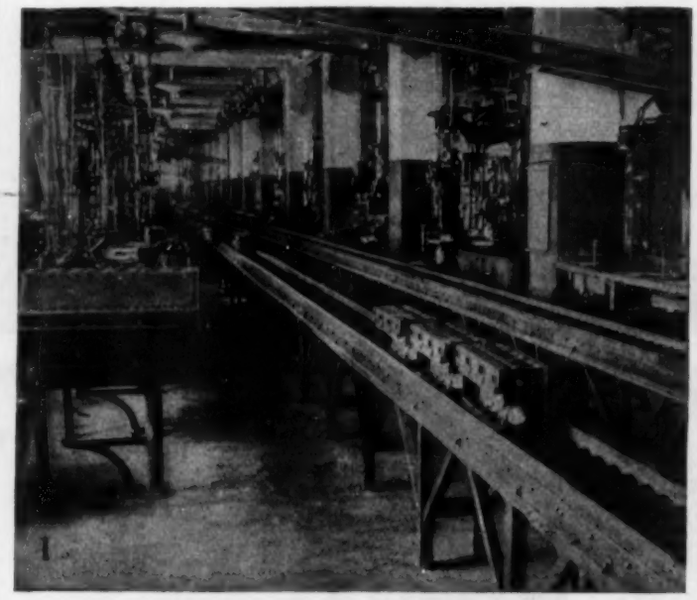
W. J. Savage Co., Inc.

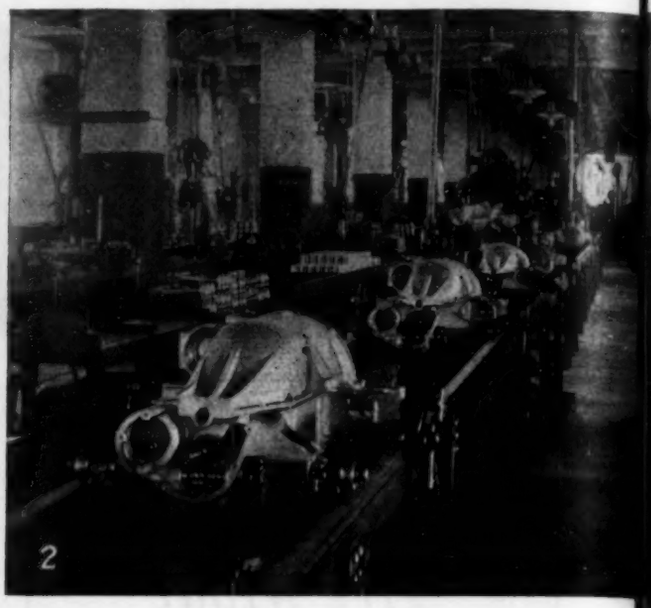
Knoxville, Tenn.

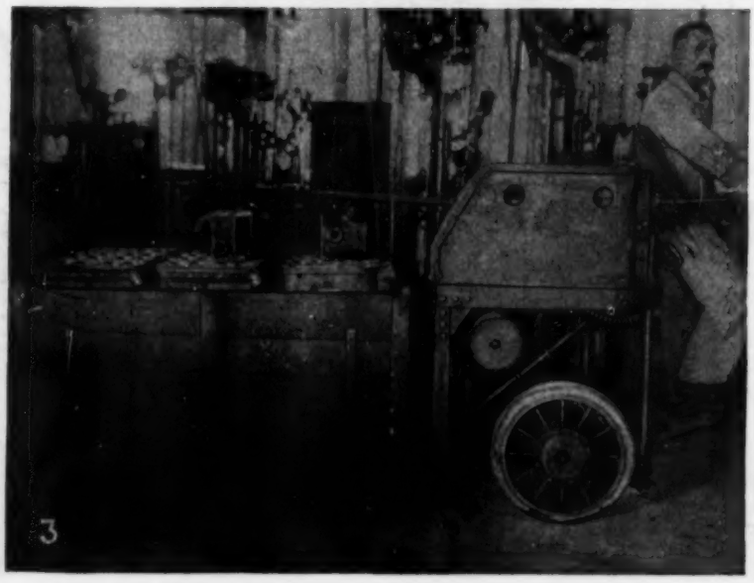
Founded 1885











Transportation of
in Fiat

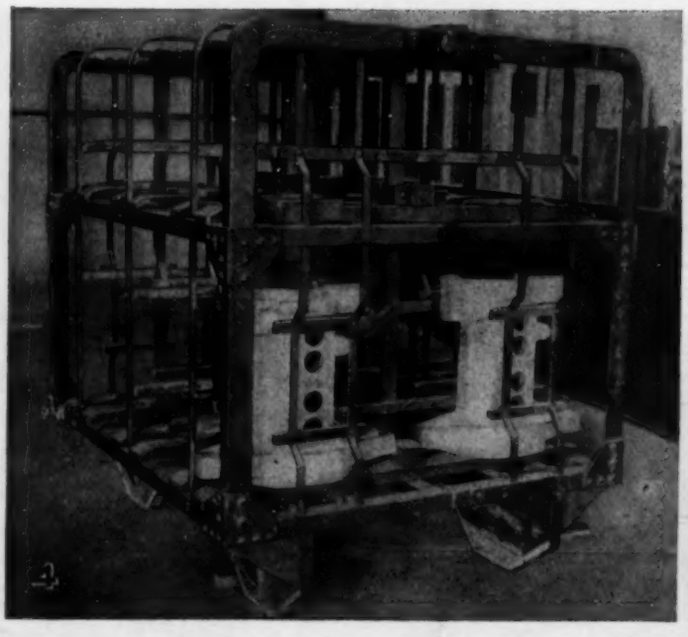
Fig. 1—Roller conveyors for cylinder blocks in process

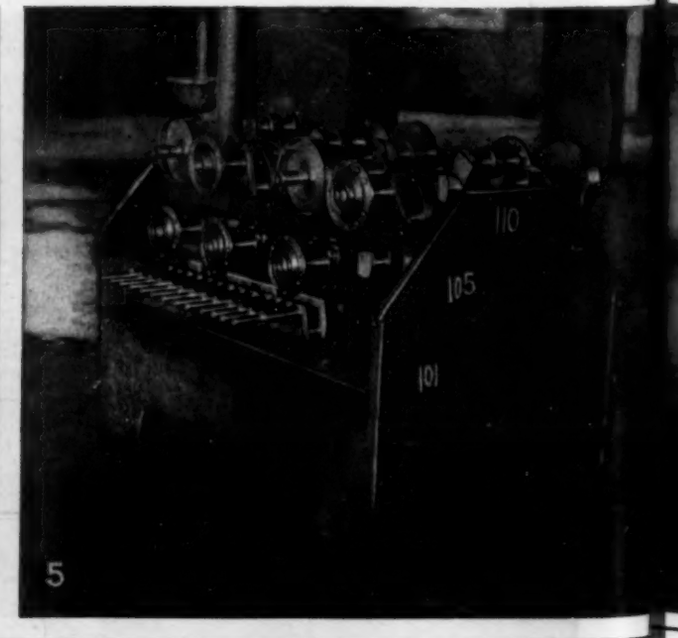
Fig. 2—Motor assembly conveyor

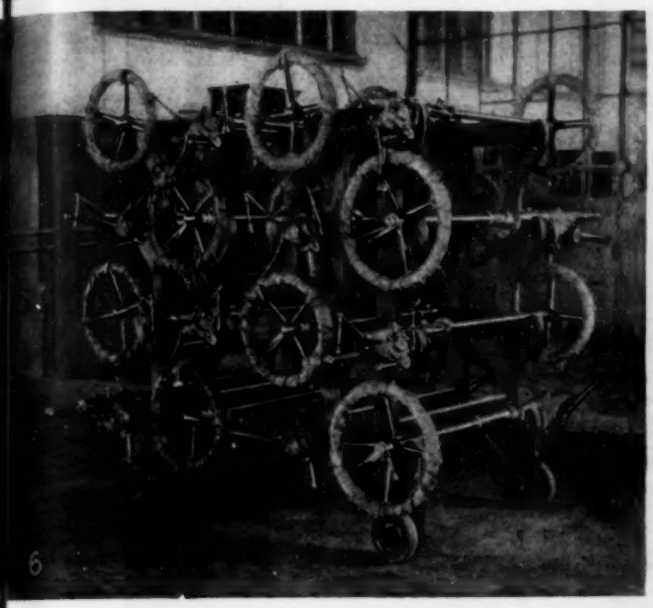
Fig. 3—Electric platform truck transports finished blocks to assembly

Fig. 4—Portable unit for trucking crankcase sections

Fig. 5—Special truck platform for crankshafts







Parts and Materials Plants

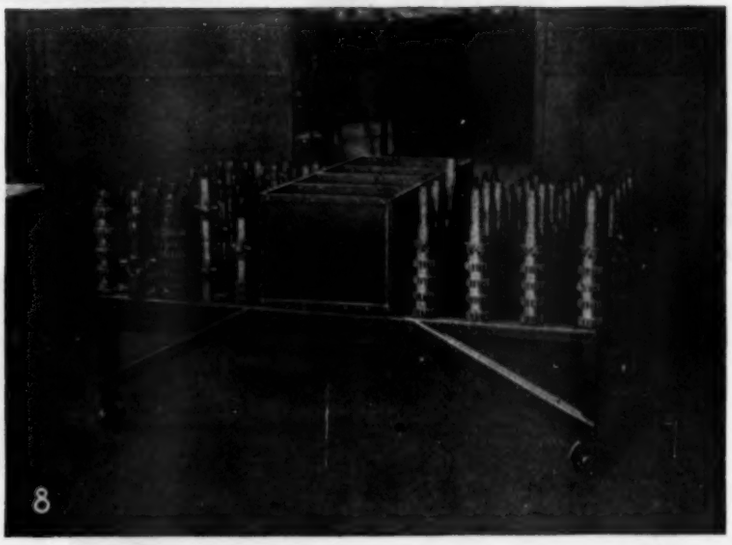
Fig. 6—Special carrier for steering gear assembly

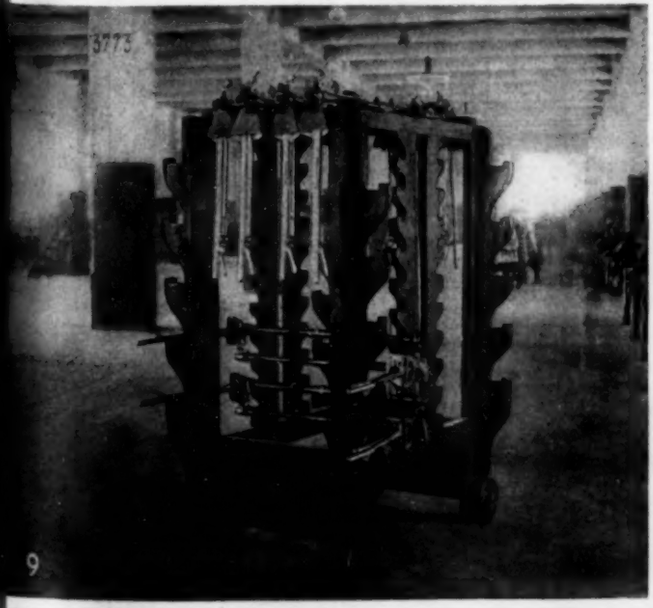
Fig. 7—Carrier for transmission unit

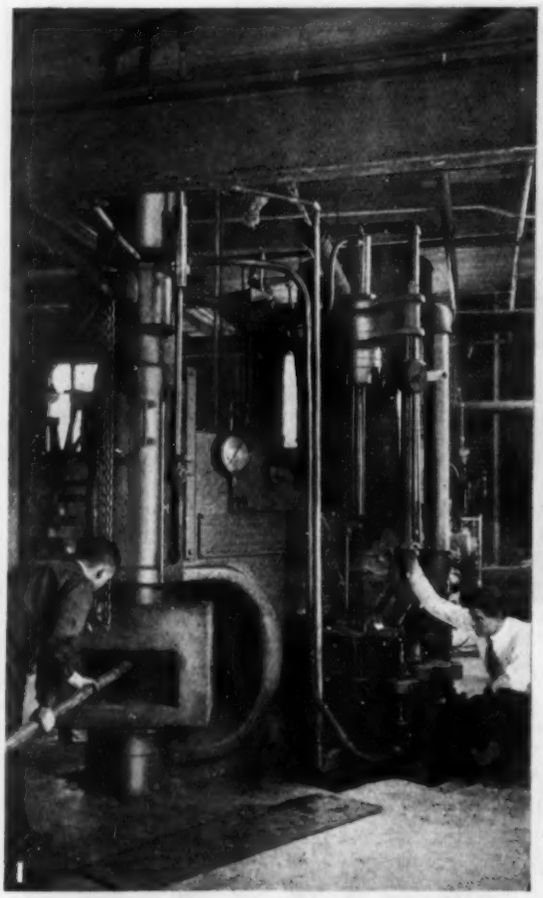
Fig. 8—Transportation unit for gears and universal joints

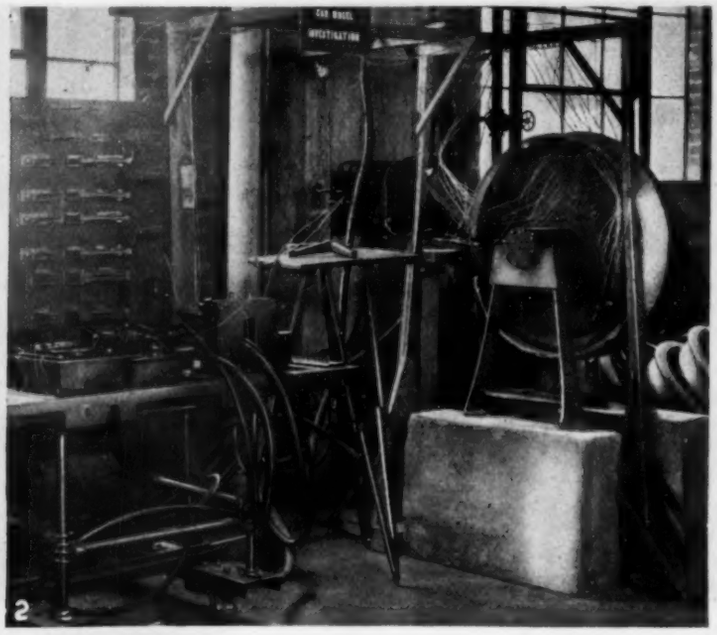
Fig. 9—Carrying frame for control lever assembly

Fig. 10—Steel carrier frame for axles









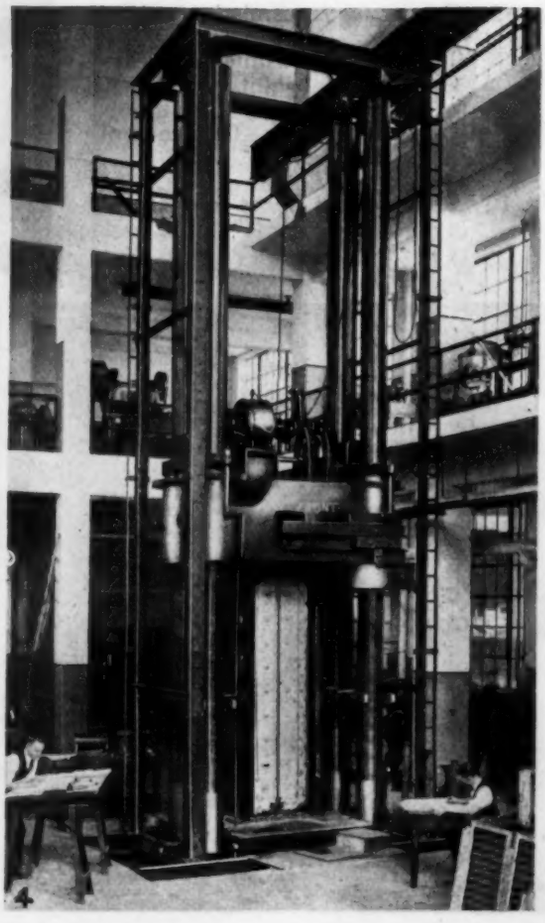
Test Work at the Bureau of Standards

Fig. 1—Pneumatic forging press in metallurgical laboratory

Fig. 2—Testing car wheels for effect of breaking or cracking of wheel

Fig. 3—Experimental foundry for various alloys

Fig. 4—Ten million pound testing machine for building columns



Automotive Production

Formulas and Data for Friction Clutches

By George W. Drake

Formulas and data for cone, split-ring and disk friction clutches—Practical examples of the application of the formulas

MUCH has been written on the subject of friction clutches and the term "accepted formulas for friction clutches" has become familiar. It would be expected, therefore, that the latest handbooks would give acceptable and accurate formulas and data for the design of such clutches, but a rather thorough examination of several of them is disappointing in this regard. Without going into the details of the shortcomings of the handbooks in this respect at this time, I deem the subject of sufficient importance to present a comprehensive series of formulas and data.

One of the main difficulties with the published material on this subject is the non-uniformity of the nomenclature. In the following formulas I have endeavored to adopt the best features of the various methods of presentation in the hope that it may perhaps lead to a little more uniformity and considerably less

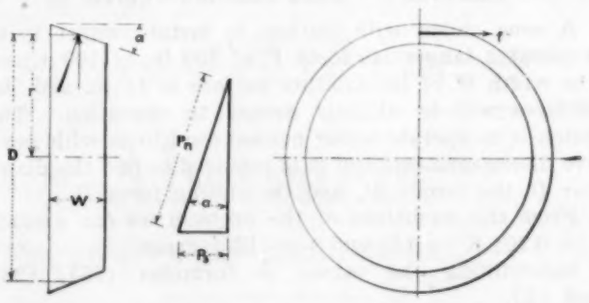


Fig. 1—Diagrams of a cone friction clutch

confusion in the minds of those who have to use them. All the formulas apply to clutches that are to be engaged with a slight amount of slip. For convenience the following symbols are used:

F = Tangential or turning force
M = Turning moment or torque in in.-lb.
P_s = Spring pressure, axial or closing force
p = Allowable normal pressure in lb. per sq.in.
P_n = Total normal pressure
r = Mean radius of friction surface
D = Mean diameter of friction surface
a = Angle of friction surface with shaft in cone clutch
A = Area of friction surface
N = R.p.m.
V = Velocity at mean radius in ft. per min.
W = Width of friction surface
f = Coefficient of friction
HP = Horsepower
K = Allowable tractive or turning force per sq.in. of friction surface, known as Edgar's Constant.

Cone Friction Clutches

From the force diagram in Fig. 1, it will be seen that $\sin a = = \frac{P_s}{P_n}$

Therefore,

$$P_s = P_n \sin a = \frac{F \sin a}{f} = \frac{M \sin a}{fr} \quad (1)$$

$$F = \frac{P_s f}{\sin a} \quad (2)$$

$$M = \frac{P_s f r}{\sin a} \quad (3)$$

$$P_n = \frac{P_s}{\sin a} \quad (4)$$

Split-Ring Friction Clutches

From the force diagram at the left in Fig. 2, it is apparent that the force P_s acts through a distance equal to the distance through which the force $\frac{P_n}{2}$ acts multiplied by π. Since the products of these forces multiplied by the distance through which they act must be equal, $P_s \times \pi = \frac{P_n}{2}$. Therefore,

$$P_s = \frac{P_n}{2\pi} = \frac{P_n}{6.283} \quad (5)$$

$$P_n = 6.283\, P_s \quad (6)$$

$$F = 6.283\, P_s f \quad (7)$$

$$M = 6.283\, P_s f r = 3.1416\, D P_s f = 1.57\, D^2 W p f = 1.57\, D^2 W K \quad (8)$$

$$P_s = \frac{M}{3.1416\, D f} = \frac{F r}{3.1416\, D f} \quad (9)$$

The above formulas are for rings split in one place.

AUTOMOTIVE PRODUCTION

When the ring is split in two places, as shown at the right in Fig. 2, the closing force P_s becomes twice as great for the same turning force and

$$P_s = \frac{P_n}{\pi} = \frac{P_n}{3.1416} \quad (10)$$

$$P_n = 3.1416\,P_s \quad (11)$$

$$F = 3.1416\,P_s f \quad (12)$$

$$M = 3.1416\,P_s fr = \frac{3.1416\,DP_s f}{2} = \frac{1.57\,D^2WPf}{2} = \frac{1.57\,D^2WK}{2} \quad (13)$$

$$P_s = \frac{2M}{3.1416\,Df} \quad (14)$$

The reason for the increased closing force when there are two splits will be apparent from an inspection of Fig. 2. At the left the forces R_s are reaction forces due to the forces P_s being constrained to act in a curve, the two forces becoming opposed to each other at a point 180 deg. from the split. Therefore, we have opposite and equal reaction forces. With the double split the two additional forces P_s are theoretically equal to the reaction forces and the closing force will be twice as great with two splits as with one.

Multi-Disk or Plate Friction Clutches

The arrangement of multi-disk or plate friction clutches is shown in Figs. 3 and 4. In the consideration of these devices an additional symbol is needed.

n = Number of pairs of friction surfaces in contact; usually one less than the number of disks

$$F = P_s fn \quad (15)$$

$$M = P_s fnr \quad (16)$$

$$P_s = \frac{F}{fn} \quad (17)$$

$$P_s = \frac{63{,}025\,HP}{Nnrf} \quad (18)$$

$$HP = \frac{P_s Nnrf}{63{,}025} \quad (19)$$

$$HP = \frac{KD^2WNn}{40{,}120} \quad (20)$$

$$n = \frac{63{,}025\,HP}{P_s Nrf} \quad (21)$$

Formulas for All Types

$$F = 3.1416\,DWK = P_n f = \frac{M}{r} \quad (22)$$

$$M = Fr = P_n fr = \frac{63{,}025\,HP}{N} \quad (23)$$

$$HP = \frac{MN}{63{,}025} = \frac{KD^2WN}{40{,}120} \quad (24)$$

$$W = \frac{F}{\pi DK} = \frac{0.636\,M}{D^2K} \quad (25)$$

$$V = \frac{\pi DN}{12} = 0.262\,DN \quad (26)$$

$$A = 3.1416\,DW \quad (27)$$

$$D = \sqrt{\frac{0.636\,M}{WK}} = \frac{F}{3.1416\,WK} \quad (28)$$

The foregoing formulas will be found of value in the design of friction clutches of various types. A few practical examples of the use of the data will be given to make the reader familiar with the method of procedure in using the material.

Example I—Cone Friction Clutch

Let us find the torque M, the width of face W, and the closing force required P_s, for a 12-in. clutch running at 100 r.p.m. and transmitting 20 hp. The friction surfaces are metal to metal and will run slightly greasy, operating under normal conditions with positive disengagement.

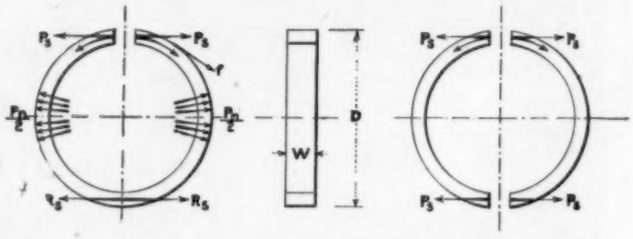


Fig. 2—Split-ring friction clutches

Therefore, $HP = 20$; $N = 100$; $D = 12$; and we can assume for the given conditions that $f = 0.15$; $K = 50$; and $\alpha = 12$ degrees.

Substituting these values in formulas (23), (25) and (1),

$$M = \frac{63{,}025\,HP}{N} = \frac{63{,}025 \times 20}{100} = 12{,}605 \text{ in.-lb.}$$

$$W = \frac{0.636\,M}{DK} = \frac{0.636 \times 12{,}605}{144 \times 50} = 1.11 \text{ in.}$$

$$P_s = \frac{M \sin \alpha}{fr} = \frac{12{,}605 \times 0.208}{0.15 \times 6} = 2{,}913 \text{ lb.}$$

Example II—Cone Friction Clutch

A cone clutch with leather to metal contact is to transmit a tangential force F of 800 lb. at 100 r.p.m. The width W of the friction surface is 1¼ in. and the surfaces will be slightly greasy in operation. The clutch is to operate under normal conditions with positive disengagement, and it is required to find the diameter D, the torque M, and the closing force P_s.

From the conditions of the problem we can assume $f = 0.20$; $K = 14$; and $\alpha = 12$ degrees.

Substituting the values in formulas (28), (23) and (1),

$$D = \frac{F}{3.1416\,WK} = \frac{800}{3.1416 \times 1.25 \times 14} = 14.58 \text{ in.}$$

$$M = Fr = 800 \times 7.29 = 5{,}382 \text{ in.-lb.}$$

$$P_s = \frac{F \sin \alpha}{f} = \frac{800 \times 0.208}{0.20} = 832 \text{ lb.}$$

Example III—Split-Ring Clutch

An 8-in. split-ring clutch, with lubricated metal-to-metal friction surfaces and operating at speeds up to 1,000 r.p.m. with frequent engagement, has a width of 1½ in. The tangential force F, horsepower HP, and closing force P_s are required.

It can be assumed that $f = 0.08$ and $K = 25$, and the substitution of the numerical values in formulas (22), (24) and (9) gives the following values:

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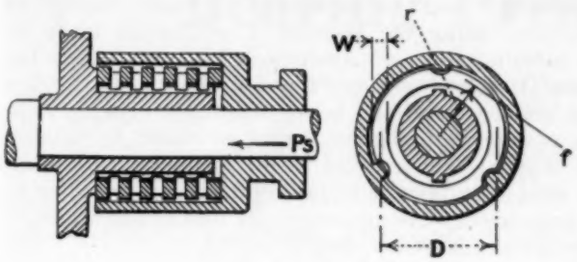

Fig.3

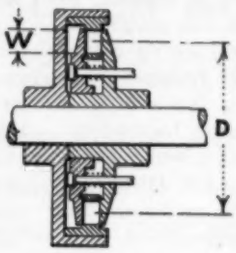

Fig.4

Fig. 3—Multiple-disk friction clutch. Fig. 4—Single-disk clutch

The above specifications are practically the same as for the Ford clutches. The closing force P_s is the pressure against the end disk and not the pressure of the spring itself. In the Ford clutch the spring exerts a pressure of about 90 lb. against the clutch fingers and these fingers press against the push ring that bears directly on the end ring of the clutch with a force of about 325 lb. The force required at the pedal to disengage the clutch is about 25 pounds.

$$F = 3.1416\,DWK = 3.1416 \times 8 \times 1.5 \times 25 = 942.\text{ lb.}$$

$$HP = \frac{KD^2WN}{40{,}120} = \frac{25 \times 64 \times 1.5 \times 1{,}000}{40{,}120} = 59.8\text{ hp.}$$

$$P_s = \frac{Fr}{3.1416\,Df} = \frac{942 \times 4}{3.1416 \times 8 \times 0.08} = 1{,}875\text{ lb.}$$

EXAMPLE IV—MULTIPLE-DISK CLUTCH

The following data are given for a multiple-disk clutch with metal-to-metal friction surfaces submerged in oil and operating under severe conditions, as in motor-car service.

D (mean diameter) $= 5\frac{1}{16}$ in.; $W = \frac{11}{16}$ in.; $N = 1{,}725$ r.p.m.; $n = 24$.

Under the conditions the following assumptions can be made: $f = 0.04$; $K = 1.0$. The horsepower transmitted and the closing force required are found by substituting the given and assumed values in formulas (20) and (18).

$$HP = \frac{KD^2WNn}{40{,}120} = \frac{1 \times 28.22 \times 0.687 \times 1725 \times 24}{40{,}120} = 20$$

$$P_s = \frac{63{,}025\,HP}{Nnrf} = \frac{63{,}025 \times 20}{1{,}725 \times 24 \times 2.656 \times 0.04} = 286\text{ lb.}$$

EXAMPLE V—SINGLE-DISK CLUTCH

The following values are given for a single-disk clutch: D (Mean diameter) $= 8.375$; $W = 1\frac{1}{2}$; $N = 1{,}600$; $n = 2$. The friction surfaces are asbestos fabric on metal and are run slightly greasy in motor-car service. The assumed values will be $f = 0.30$; $K = 5$.

It is desired to find V, A, HP, and P_s, and the numerical values will be substituted in formulas (26), (27), (24) and (18).

$$V = 0.262\,DN = 0.262 \times 8.375 \times 1{,}600 = 3{,}512\text{ ft.}$$

$$A = 3.1416\,DW = 3.1416 \times 8.375 \times 1.5 = 30\text{ sq.in.}$$

$$HP = \frac{KD^2WN}{40{,}120} = \frac{5 \times 70.14 \times 1.5 \times 1{,}600}{40{,}120} = 21\text{ hp.}$$

$$P_s = \frac{63{,}025\,HP}{Nnrf} = \frac{63{,}025 \times 21}{1{,}600 \times 2 \times 4.1875 \times 0.3} = 329\text{ lb.}$$

The above specifications are similar to those for the Borg & Beck clutch so generally used in motor cars. The reason for the popularity of this clutch is that it combines a positive yet gradual clutching action with a prompt release. The closing system is very powerful, the spring pressure being multiplied by a series of levers, toggles and wedges.

Abstracts

from other publications

Building Tractors Under Scientific Management

George D. Babcock, manufacturing executive, the Holt Manufacturing Co., states that chief among the principles governing successful plant operation is pre-planning. Back of the authorization of the manufacturing schedule is the decision of the general policy of the company, and pre-planning is just as essential here as it is for the activities of the shop and this pre-planning is the job of the executives.

The most important questions to be answered are those that deal with the volume of sales during the next year, and secondly how much money will be needed to finance the business of the company for that period.

There are many other problems that confront the executives such as labor policies; the question of employee representation; the policy regarding purchasing and the various supply markets; and whether certain parts should be purchased outside or made by the company.

There is also the question of the engineering of the product. All these are important points to be planned. A close touch is kept between production and sales at the Holt company, by keeping a close inventory on the tractors available for shipment, and whether it is consistent with the sales. The plotting of the two curves will indicate whether or not production is proceeding at too rapid a rate for the market to absorb it.

This careful day by day survey of conditions, Col. Babcock states, had had much to do with the enviable production record that the shop has achieved during the past three years. Sales are just as susceptible of pre-planning as manufacturing, and in starting this work for the Holt company, a survey of the entire world was made to determine the extent of the possible markets that could be reached. For example the pos-

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sible extent of the market for tractors for logging in the Northern woods of the United States was estimated, and also the market for tractors in the logging camps in the Southern swamps. This survey resulted in a definite manufacturing program, calling for a definite number of tractors of each type and design to be delivered to the sales department over a given period. Col. Babcock relates their attitude toward labor and their experience with shop employees to represent the men in their dealings with the management. A committee was selected entirely by the men, the management taking no part whatever in the selection.

For reasons that are detailed in the article, this committee was not altogether a success chiefly because the committee did not really represent the men and the opinions were distorted when they reached the management. The most successful and natural solution to be found was to deal in all matters relating to labor just as a company would carry on its relations with any other individual or group. Employees are confident of the earnestness of the company and the honesty of intentions in their dealings. The men like scientific management and feel that it is easier and better for them to work now than before.—*Management and Administration*, November, p. 497.

Duralumin

Horace C. Knerr, pointing out the rapid increase in the use of duralumin in the construction of aircraft and automobiles, states that this has brought out the need for condensed information on the characteristics of the material and the best methods of treatment and fabrication. The term duralumin also includes the alloy manufactured under the trade symbol "17S" and has a composition as follows: Copper, 3.5 to 4.5 per cent; magnesium, 0.2 to 0.75 per cent; manganese, 0.4 to 1.0 per cent; aluminum (min.), 92 per cent.

It is produced in the form of sheet, strip, rod, bar, wire, seamless tube and extruded sections. It may be purchased in any one of four conditions, namely: As rolled, forged or extruded; annealed; heat treated, or cold rolled after heat treating.

Its tensile strength in the heat treated state is about the same as that of mild carbon steel, namely 5,500 to 6,000 lb. per sq.in. with an elongation of 17 to 22 per cent in 2 in., and weight 5 per cent greater than that of aluminum, its specific gravity being about 2.82.

This article then proceeds to give the details of heat-treating, quenching, means of heating, containers for salt bath, forming, tube bending and spinning.

Under the heading of forging, Mr. Knerr states that duralumin makes excellent plain or die forgings when properly handled. It is somewhat delicate at forging temperatures and sensitive to underheating or overheating. Quantity production has been reached without difficulty in ordinary oil or gas-fired semi-muffle furnaces. Forging temperatures between 660 and 840 deg. F. are recommended.

Under riveting he states that rivets are made cold from annealed wire in a rivet-heading machine. They are heat treated immediately before use, and driven while still soft, that is within 30 minutes after quenching.

Duralumin may be welded in the same manner as aluminum, using the Welding Flux No. 22 made by the Aluminum Co. of America. Soldering up to the present time has not been found practical. It is not a good bearing metal and is not adapted to making castings. It can be protected against corrosion by using a coat of spar varnish mixed with 2 to 3 per cent American Blue. Duralumin is subject to corrosion when in the presence of moisture, especially that of salt water.—*Automotive Industries*, Oct. 9, p. 648.

Noisy Gears

C. M. Aldrich, gear engineer of the Olds Motor Works, discusses the fundamental causes of noisy gears and gives suggestions for preventing objectionable noises.

He first of all considers some theoretical conditions such as a smooth disk revolving in the air, and then points out that the tendency today is to add operations that either remove the roughness of the surface of the teeth or correct the tooth spacing. It has been more or less successful, but calls for an unusual degree of accuracy in manufacturing and, of course, added expense. Mr. Aldrich's method is to eliminate rather than add operations, and to compensate for, rather than attempt to decrease inaccuracies.

The three major causes for noisy gears are inaccuracy in the gears, inaccuracy in other parts of the assembly and inaccuracy in tool manufacture.

Most machines on the market for hobbing gears are handicapped owing to the fact that it is necessary to make each machine universal, which means that a large train of gears is necessary to transmit motion from the work arbor to the hob arbor. Inaccuracies in this set-up lead to further inaccuracies in the gear.

One suggestion made is when the hob is put on the machine it should be indicated on both hubs and that the extreme allowable limit of run-out should be 0.0005 in.

It is not necessary to center a hob longitudinally. Absolute neatness and cleanliness in the operation of a hobbing machine is of great importance. The gears being cut must be watched continually for running-out errors, both on the face and on the periphery.

The importance of accuracy in center distances cannot be overestimated, as there is a positive limit to the variation in backlash at which gears will run quietly.

A somewhat unusual suggestion is made that if we are to produce quiet gears on a quantity basis, we must develop a new tooth form that will somewhat compensate for other inaccuracies. It is Mr. Aldrich's opinion based upon practical tests, that the ideal tooth form and the one that will eventually come into general use is a combination of the two standard tooth forms that are now used. This tooth form will have a cycloidal root and point, with a short length of involute flank between. The cycloidal portion will insure a true rolling contact, to some extent, while the involute portion will compensate for the variations in center distance. However the first step in developing a new tooth form is the development of an accurate method of measuring present tooth forms.

The article also describes the authors' method.—*Machinery*, October, p. 116.

Bearing Pressures and Friction

By Louis Illmer and Leonard N. Linsley

Abstract of two papers presented at A.S.M.E. annual meeting—Effects of quality and quantity of oil—Friction coefficients—Ultimate load capacities and breakdown pressures

TWO papers were presented at the annual meeting of the American Society of Mechanical Engineers, Dec. 1-4, 1924, dealing with the subject of bearing pressures and friction, the first by Louis Illmer, entitled "High-Pressure-Bearing Research," and the second by Leonard N. Linsley entitled "An Investigation of the Critical Bearing Pressures Causing Rupture in Lubricating Oil Films." Abstracts from these two papers are given here.

The first paper is more particularly directed toward the intermediate field of friction that lies between perfect film and dry metallic friction.

The problem involved in the second paper is to determine the critical or break-down pressure in the oil films formed in a bearing, using straight mineral oils and also when admixtures of definite amounts of oleic acid are made. In a way the second paper may be regarded as supplementing the first.

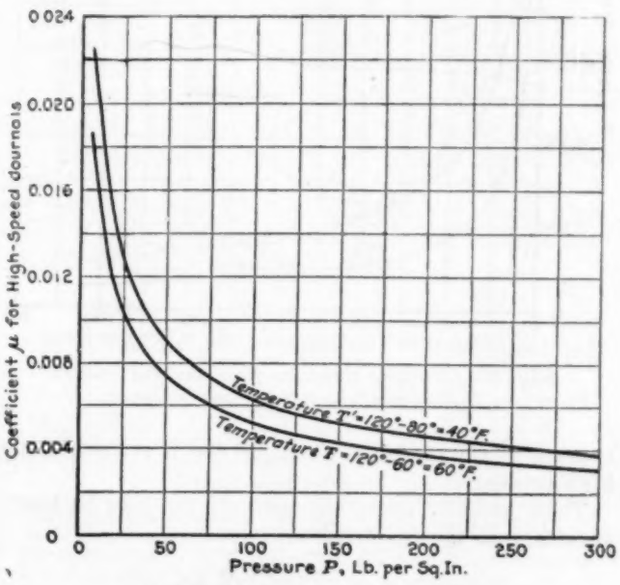


Fig. 1—Coefficient of friction for perfect oil films

Mr. Illmer presents in his paper a synopsis of some research investigations into the laws of friction and deduces a practical method for determining friction coefficients as based upon a wide range of high-pressure bearing practice. As compared with the friction coefficient for perfect lubrication, the breaking down of the oil film introduces a number of additional variable factors that affect such coefficients, and these change with conditions of service. Certain constants are therefore presented to serve as a guide in appraising the various modifying factors, appropriate for any given set of operating conditions under partial lubrication.

Perfect Film Friction

The effect of partially breaking down the oil film can more readily be traced by taking up first the case of completely oil-borne journals. The coefficient of friction is dependent upon four principal factors, which may be summarized as follows:

(a) Quality of Oil Used, especially as regards its viscosity characteristics. The change in viscosity is largely controlled by temperature; for ordinary grades of mineral oil a suitable allowance for this change may be made by introducing a temperature factor.

(b) Quantity of Oil Used. Experiments clearly show that when any bearing is operated with a stinted oil supply, the coefficient of friction will be materially higher than when the same bearing is served with a copious and evenly distributed oil supply.

In the case of fast-running oil-borne bearings the minimum of friction is assured when at least one gallon of lubricant is fed for each 350,000 sq.ft. of journal surface passed over the rubbing area. A supply in excess of this stipulated amount will be termed flooded lubrication.

(c) Radiating Capacity. This will vary under different temperature heads and it is also dependent upon the massiveness of the bearing construction.

(d) Pressure and Temperature Factors. When a rigid journal is worn to a proper fit and copiously supplied with a suitable lubricant, the friction coefficient is primarily determined by the unit working pressure and the temperature attained by the rubbing surfaces.

As applied to an oil-borne journal rotating at relatively high speeds, its value is given by the following simplified formula:

$$\mu = \frac{2}{5\sqrt{PT}}$$

where

μ = coefficient of friction for perfect oil-film lubrication as applied to a flooded rotating journal;

P = mean specific or unit pressure carried by an oil-borne bearing, lb. per sq.in. of projected area;

$T = t_1 - 60° =$ virtual temperature for the more common grades of mineral engine oils, deg. fahr.;

t_1 = temperature of the rubbing surface which should be limited to about 200 deg. F.

A series of values for the perfect film friction coefficient μ as determined from this equation are plotted in Fig. 1.

In order to lift the journal against a given unit bearing pressure and permit of fully establishing an oil film, it is necessary to run the rubbing surface above a certain critical velocity. The speed needed for this purpose when using the more common grades of mineral engine oils, was found to be approximately that given by the equation

$$P_c = 140\sqrt[4]{\frac{V}{T}}$$

where

P_c = critical pressure at or below which a perfect oil film may be maintained under a journal when running at a given rubbing velocity V, lb. per sq.in. of projected area.

V = mean surface or rubbing velocity of a rotating journal, ft. per min.

Imperfect Film Friction

When the unit working pressure P assumes a value equal to P_c, the coefficient μ will then be reduced to the minimum value expected in good practice, namely,

$$\mu_{min} = \frac{2}{5\sqrt{P_c T}}$$

This value serves as a standard of reference and will be so used in the discussion that follows. It will be apparent that when the average working pressure is allowed to exceed the critical pressure P_c, the friction

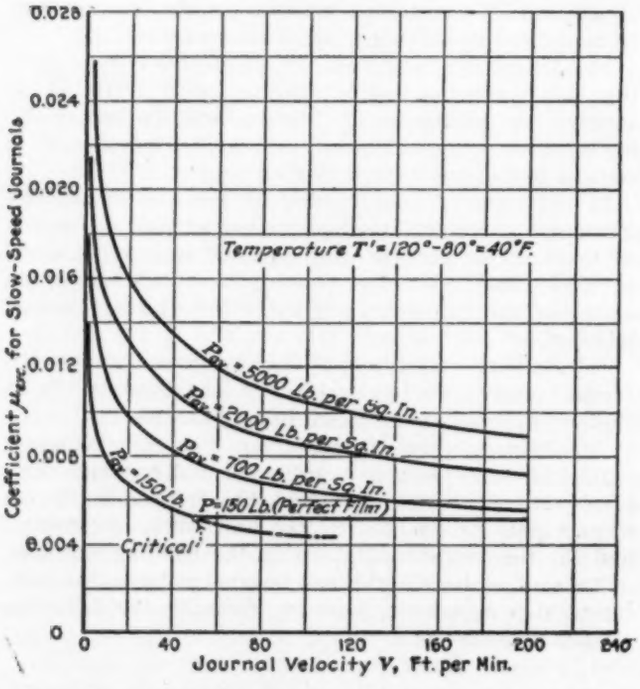


Fig. 2—Coefficient of friction for imperfect oil films

losses will thereby be augmented because the journal can no longer ride on a perfect film of oil. When operating under such imperfect conditions, the working pressure will be denoted by P_{av} and the corresponding friction coefficient will be designated as μ_{exc}.

Contrary to prevailing opinion, however, it is found that the transition from a perfect oil film to a partial oil film does not produce an abrupt rise in the friction coefficient. Instead, the breaking down of the oil film causes a gradual increase in friction, depending largely upon the ratio P_{av}/P_c.

When thin mineral oils are put under a pressure of about 10,000 lb. per sq.in., their viscosity will be raised to more than double that determined under atmospheric pressure.

In the case of partial film lubrication there are, in addition to the noted increase of viscosity, other important factors that must be taken into account when fixing upon the friction coefficient under extreme pressures. Of these may be cited the need for heavier grades of lubricants to maintain the required thickness of oil film; also the increasing effect of unevenness in the rubbing surfaces, since this becomes more pro-

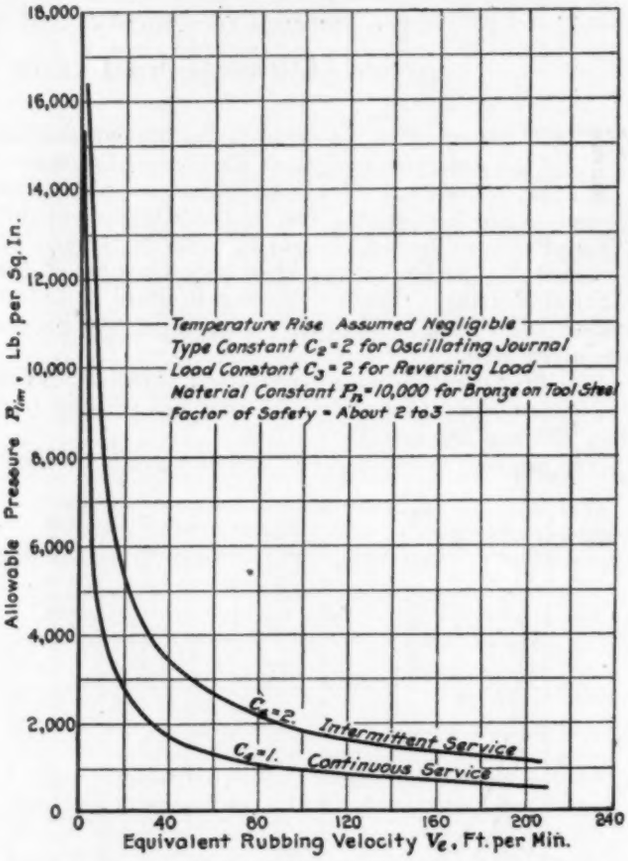


Fig. 3—Limiting average pressure for pintle blocks as determined by last equation

nounced as the thickness of the oil film is reduced under high pressures.

These and like uncertain elements can best be incorporated into the following equations:

$$\mu_{exc} = \mu_{min}\sqrt[4]{\frac{P_{av}}{P_c}} = \frac{2}{5\sqrt{P_c T}}\sqrt[4]{\frac{P_{av}}{P_c}}$$

where μ_{exc} = coefficient of friction under conditions of partial oil film lubrication as applied to a journal bearing flooded with suitable mineral oil;

P_{av} = average dead-load pressure on the rubbing surface when $P_{av} > P_c$ lb. per sq.in. of projected area.

The coefficient of friction applying to a flooded rotating journal after the oil film has been partially broken down where $P_{av} > P_c$, becomes approximately equal to:

$$\mu_{exc} = \frac{1}{100}\sqrt[4]{\frac{P_{av}}{VT}}$$

where V is the mean velocity or average of movement between the rubbing surfaces in ft. per min.

Some values derived from this equation have been plotted in Fig. 2. It is evident that the coefficient μ_{exc} may still be reasonably low, although the use of

an excessive working pressure has broken down the oil film. The value of μ_{exc} can, however, in no case assume a value less than the corresponding coefficient μ. Under ordinary service conditions the friction resulting from imperfect lubrication is usually several times greater than that which applies in the case of completely oil-borne journals.

For moderately heavy mineral oils such as are needed at higher pressures, the corresponding increase in viscosity may be compensated for by substituting $T' = t_1 - 80°$ in the place of the previously given $T = t_1 - 60°$. Extreme pressure may require still heavier lubricants such as cylinder oil, and for this a value of $t - 100$ deg. F. may be used.

The equation embodies the basic relations sought for determining high-pressure friction coefficients for rotating journals; the remainder of the paper will center largely about this deduction.

In arriving at a normal or expected value for the coefficient μ_{exc} under ordinary conditions of high-pressure service, no appreciable error will be involved

Table I—Values of Circumstance Constant C_1

C_1	Lubrication	Workmanship	Attendance	Location
1	Oil bath or flooded	High-grade	First class	Clean and protected
2	Oil, free drop (constant feed)	Good	Fairly good	Favorable (ordinary conditions)
4	Oil cup or grease (intermittent feed)	Fair	Poor	Exposed to dirt or grit or other unfavorable conditions

by fixing the bearing temperature at a constant value $t_1 = 120$ deg. Fahr., i.e., $T' = 40$ deg. Fahr. The equation then takes the following form which may be used for estimating the friction coefficient under high pressures when working with a moderate temperature rise and without perceptible abrasion:

$$\text{Where } P_{av} > P_c: \qquad \mu_{exc} = \frac{C_1 C_2}{250}\sqrt[4]{\frac{P_{av}}{V}}$$

in which C_1 and C_2 are respectively circumstance and bearing-type constants taken from Tables I and II.

In order to arrive at a correct appraisal of the coefficient μ_{exc}, the quantity of oil supplied to the journal must still be taken into account.

Table II—Values of Type Constant C_2

C_2	Type and example of bearing
1	Rotating journals, such as rigid bearings and crankpins
1	Oscillating journals, such as rigid wristpins and pintle blocks
2	Rotating journals lacking ample rigidity, such as eccentrics and the like
2	Rotating flat surfaces lubricated from center to circumference such as annular step or pivot bearings, etc.
2-3	Sliding flat surfaces wiping over the guide ends, such as reciprocating crosshead shoes. Use 2 for relatively long guides and 3 for short guides
3-4	Sliding or wiping flat surfaces lubricated from the periphery or outer wiping edge, such as marine thrust bearings and worm gears
4-6	Long power-screw nuts and like wiping parts over which it is difficult to effect a uniform distribution of lubricant or load

Furthermore, rigidity of the bearing structure, workmanship, attendance, location, and similar conditions are also likely to exert considerable influence upon the resulting friction. Allowances for these modifying factors have been incorporated into the equation by means of the circumstance constant C_1.

All of the equations thus far deduced are intended to apply to rigid bearings provided with rotating journals. A different method for working the lubricant between the rubbing surfaces is found to modify the resulting coefficient of friction.

The introduction of the constant C_2 as given in Table II makes an allowance for differences in the type of bearings and also for the method of applying the lubricant to flat surfaces.

Approximate material constants, designated as P_n, are given in Table III, and these apply to the various combinations of bearing surfaces commonly employed.

Table III—Values of Material Constant P_n

Materials in Contact	P_n Lb. per Sq.In.	Remarks
Hardened tool steel on lumen or phosphor bronze	10,000	The given values apply to rigid polished and accurately fitted rubbing surfaces.
0.50 *C* machine steel on lumen or phosphor bronze	8,000	When not worn to a fit or well lubricated, reduce values to about $\frac{1}{4}$ P_n.
Hardened tool steel on hardened tool steel (common grades)	7,000	
0.50 *C* machine steel or wrought iron on genuine hard babbitt	6,000	
Cast iron on cast iron (close grained or chilled)	4,500	
Case-hardened machine steel on case hardened machine steel	4,000	
0.30 *C* machine steel on cast iron (close grained)	3,500	
0.40 *C* machine steel on soft common babbitt	3,000	
Soft machine steel on machine steel (not case-hardened)	2,000	
Machine steel on lignum-vitae (water-lubricated)	1,500	

Ultimate Load Capacity

In determining the ultimate load capacity of a slow-moving bearing when working without appreciable heating effects, the oil supply constant C_1 is no longer a factor of importance, except that the rubbing surfaces must still be reasonably well lubricated. The following empirical formula may be used for finding the allowable limit pressure for well-fitted heavy-duty bearings running on a partial oil film, the underlying factor of safety with respect to abrasion being about 2 to 3 when the constant $C_4 = 1$:

Where $V \leqq 1$ ft. per min.,

$$P_{lim} = 0.6 C_3 C_4 \frac{P_n}{\sqrt[3]{V_e^2}}\sqrt[3]{H}$$

Where

P_{lim} = limiting average dead-load pressure allowable under negligible heating effects, lb. per sq.in. of projected area;

C_4 = load constant as given in Table IV.

Table IV—Values of Load Constant C_4

C_3	Load Characteristics	Example of Bearing
1	Dead or steady load	Such as generator main bearings
3–2	Variable or peak load	Such as punch and shear crankpins
2	Reversing loads	Such as steam-engine wristpins

C_4 = intermittency factor; for continuous service = 1; for intermittent service, 1½ to 2;

V_e = equivalent rubbing velocity, ft. per min. For slow-moving oscillating loads this may be taken as inches of movement actually under load × (r.p.m. ÷ 6);

H = specific radiating capacity per sq.in. of maintained projected area of bearing:

H = about 2 for babbitted lineshaft-hanger bearing;

= about 3 for light outboard or generator bearings without oil pockets;

= about 4 for small ring-oiler motor bearings with oil pockets;

= about 5 for heavy-duty outboard or generator bearings without oil pockets which value may be considered as a standard of reference for high-pressure work;

= about 6 for heavy-duty engine main bearings without oil pockets.

It is thought that the present study affords a suitable basis for further experimental investigation in this art. Research work directed along the lines indicated should lead to a better understanding of the rather perplexing principles that underlie imperfectly lubricated surfaces.

In the second paper under consideration Mr. Linsley describes his elaborate and painstaking experimental research work in connection with the determination of break-down pressures in oil films formed in bearings under varying conditions.

The author first presents a résumé of the work of other investigators. He describes the apparatus with which his own experiments were conducted and the characteristics of the oils used in his tests. Tests were run with cast-iron and with babbitt bearings, and the results of the final trials, which were run with two of the oils, first untreated and later treated with oleic acid, are given in tabular and graphic form.

The curves drawn in Fig. 4 give an idea of the magnitude of the break-down pressures and also show that

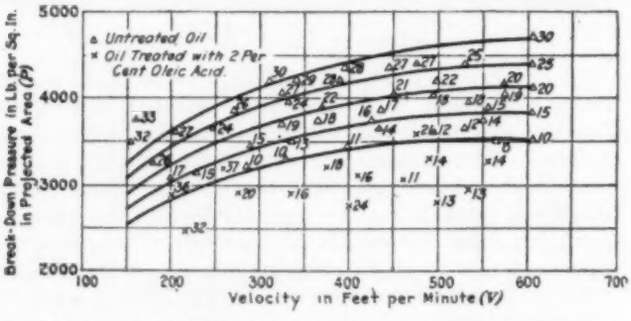


Fig. 4—Babbitt bearing 2.764 sq.in. projected area, oil No. 1, S = 205

after the oil had been treated with oleic acid these break-down pressures were materially less than with the untreated oil. (Numerals refer to absolute viscosity in poises. Circles refer to untreated oil. Crosses refer to oil treated with 2 per cent oleic acid.) Efforts to determine the break-down pressure electrically and the method of measuring film thickness are described.

The arrangement consists simply in connecting the bearing and journal in a circuit.

The theory of this arrangement is, that as long as the film is maintained, the voltage, indicated on the voltmeter, will be zero, but when the film is ruptured metallic contact occurs and the voltmeter will indicate full-line voltage.

As to the determination of the oil film thickness, during the final trial a careful determination was made of the relative position of the two halves of the bearing by means of the micrometers. The average of all observations made while using oil No. 1 are shown in Fig. 5.

In view of the fact that the clearance in the bearing was maintained entirely by the pressure of the oil film, it is thought that the values determined are a fair approximation of the oil-film thickness.

Conclusions

The most important fact brought out in this work is the astonishing intensity of pressure that the oil film will stand before being displaced.

In discussing his conclusions the author remarks that the actual break-down pressures of oils are several

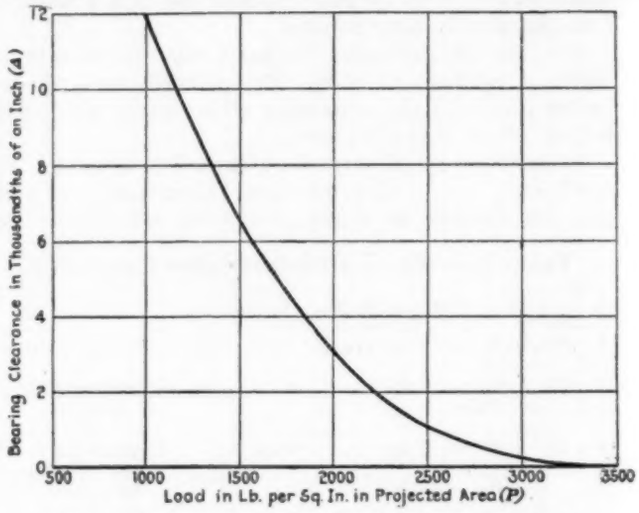


Fig. 5—Bearing clearance, oil No. 1, average of all observations

hundred times greater than have hitherto been accepted as possible. Although not definitely established, a relationship between break-down pressure, speed and viscosity was shown to exist. With reference to oils treated with oleic acid the inference cannot be avoided that oils having the same absolute viscosity but differing in chemical consistency do not have the same resistance to rupture and hence, from this point, differ in lubricating value. The paper concludes with suggestions for the extension of the experimental work and the redesign of the test apparatus.

Famous Machinists of History

By H. H. Manchester

Joseph Gillott (1799-1873)

Joseph Gillott was born in 1799, in Sheffield, which was long a center of the colliery trade of England. He was apprenticed to a collier, and after becoming a journeyman worked at the trade there. At the age of 22 years, however, he moved to Birmingham, and got a job in a shop which made buckles, pens, and filigree steel work in general. Technically, this was known at the time as the steel toy trade. From it Gillott got a good idea of the machine processes which might be employed in the making of small metal articles.

He built up a very large business, and became a liberal patron of art. He was one of the first to recognize the genius of Turner. Gillott's collection of pictures, which were sold after his death in 1873, realized about $850,000.

Production Control

By George D. Babcock

Manufacturing Executive, Holt Manufacturing Co., Peoria, Ill.

Classification of manufacturing effort—The mechanical equipment—Preplanning—Manufacturing for stock and order—Production schedule—Operation and time analysis

THE analysis and arrangement of the elements of production brought about the two great divisions of productive effort that are characteristic of modern industrial management and production control — planning and performance. In this paper the author presents an outline of the subject of production control in manufacturing, taking up for consideration respectively actual output with given equipment; preplanning; the establishment of manufacturing programs; determination of lot sizes; establishment of the production schedule; operation analysis; stores systems; dispatching of work; inspection; maintenance; and forms.

THE most efficient type of production management is based upon an application of the principles first laid down by Taylor in his classic paper Shop Management in 1903, and amplified and explained in his later writings and addresses. Taylor's great discovery in management was that scientific analysis should be substituted for rule-of-thumb and for traditional methods. Taylor's work also started the movement to put engineers in charge of the important functions in the supervision of industry, something that had up to that time been almost unknown. As a direct corollary of Taylor's discovery, the greater part of the burden of determining the best methods of doing work was shifted from the workmen to those charged with the management of the business. The reason for this shifting of the burden lay in the fact that such determinations involved many things that were beyond the control of the working force.

Among the items that are not within control of the workmen may be mentioned the following:

a The raw material used for production; its quality and the regularity of its supply.

b The equipment provided for working this raw material.

c The processes through which the raw material must pass to be converted into finished product.

d The sequence in which the various parts entering into the final product are sent into the factory.

Each of these items requires detailed and extensive investigation before the best combination for the desired final result can be found. Some of these investigations may involve heavy expense and exact technical knowledge, and may consume a considerable amount of time. Obviously, it would be impossible for the workers on their own initiative to conduct these, even if they had the inclination to do so.

Taylor's conclusions and methods were based upon the thesis that every organized effort of human endeavor can be analyzed into its fundamental elements, and that these elements can be forecast and arranged in an orderly sequence that represents the best combination to attain the desired result. This analysis and arrangement of the elements of production brought about the two great divisions of productive effort that are characteristic of modern industrial management and production control—planning and performance.

The function of planning includes all of those elements that are beyond the control of the workmen, and some of those that formerly were regarded as within their sphere. It includes a decision as to the material that will be used in the processes of the factory, the exact equipment that shall be used, the method of handling this equipment, the sequence of individual operations on each part of the product, and in the highest development of managerial science, the time that shall be taken for each operation. It also includes provision for instructing the workmen in the methods of handling the equipment so as to insure that the performance of the workman will accord with the forecast of the planning department. Upon the degree to which an industrial establishment has developed and made use of these elements of planning, depends the efficiency of production.

Manufacturing can be classified into the following divisions, ranging in order of efficiency from the lowest to the highest:

a One order for one piece. The piece never to be reproduced.

b One order for several pieces, never to be reproduced.

c Repeat orders at irregular intervals for one or few pieces.

d Repeat orders at irregular intervals for many pieces.

e Repeat orders at uniform intervals for one or a few pieces.

f Repeat orders at uniform intervals for many pieces.

g Continuous or standing orders for the same piece.

Presented at the Annual Meeting, Dec. 1 to 4, 1924, of the American Society of Mechanical Engineers, 29 West 39th St., New York.

Any industry may have in combination one or more of these classes of effort and in any analysis of the industry this should be recognized. The industry should be classified into the above classes and a control plan devised in such a manner as will secure the best results for each class. A general control plan will then be devised so as to relate the classes.

Irrespective of the class or combination of classes into which the work of a manufacturing plant falls, the efficiency of its operation will depend upon two things: (1) The efficiency in selection and use of the mechanical equipment of production; (2) The definite preplanning of every operation and event which takes place in the progress of the work through the factory. These may be considered in some detail.

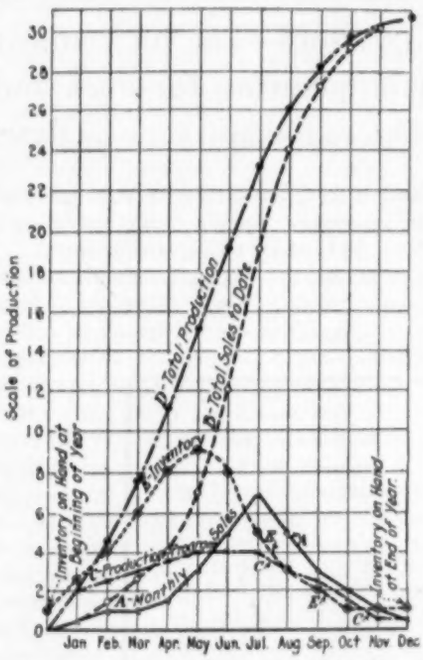


Fig. 1—Development of production program

It is obvious that the best equipment that is available for a given purpose is the most desirable. High manufacturing efficiency does not depend upon this, however. Rather it depends on the best possible use of the equipment that is available.

If manufacturing efficiency be defined by the ratio

$$\text{Efficiency} = \frac{\text{Actual Output with Given Equipment}}{\text{Maximum Possible Output with Given Equipment}}$$

it will be evident that the efficiency of the plant does not depend upon the efficiency of the equipment *per se*, but upon the efficiency with which that equipment is operated.

Efficient operation depends on the following factors:

a Maintenance of equipment in perfect operating condition, so that there will be no failures during working hours to delay production.

b Adequate power at the machine, so that it may be utilized to its full capacity.

c Proper adjustment of machines and auxiliary equipment and, in the case of machine tools, properly formed cutting tools.

d Determination of the best methods of operating the equipment, and insistence that these methods be followed.

e An adequate supply of material upon which the equipment may work, so that there will be no idle time or delays due to lack of work for any machine.

f Uniformity in the quality of raw material, permitting uniform operation at a predetermined rate. For example, excessive hardness in castings will compel slower operation of machine tools, and so decrease the predetermined production.

It follows from the foregoing that several departments are concerned in the utilization of equipment to its full capacity. Maintenance, power, and adjustment of machinery are within the province of a mechanical department. Determination of methods and an adequate supply of material at each machine are functions of preplanning. Uniform quality of material is a result of careful purchasing and rigid inspection of purchased material to insure conformity with specifications.

Maintenance can be insured by the establishment of a definite routine of inspection to discover defects, wear or misadjustment which will tend to cause failure or decrease the rate of production. When such are discovered, arrangements can then be made to effect the necessary repairs outside of working hours or at such times as will cause the least interruption to production.

Assuming that the equipment of the establishment is in first-class operating condition, and a routine has been set up that will maintain it in this condition, efficiency of production will then depend on the degree to which preplanning has been carried out.

Preplanning comprises:

a The establishment of a definite manufacturing program.

b The purchase of materials and the insurance of their delivery in ample time to carry out this program.

c The determination of the methods to be used in carrying out the program.

d The sequence of operations to be performed on each component part of the final product (Routing).

e The establishlishment of definite schedules to fix the time at which each operation in the routing shall take place.

f The dispatching of the work in the factory in accordance with the schedule.

Another function of manufacturing, supplemental to but not necessarily a part of preplanning, is the inspection of the work, both while in progress and when completed, to make sure that it is up to the standard of quality and workmanship desired. Inspection has this relation to preplanning, that when defective work is discovered, it must be replaced, and the replacements must be fitted into the manufacturing schedule without disturbance or delay.

Manufacturing may be divided into two classes as follows:

a Manufacturing for stock. Examples of this class are automobiles, food products, certain classes of electrical equipment, typewriters, etc.

b Manufacturing on orders to definite specifications furnished by the customer. Examples are hoisting and conveying machinery, locomotives, certain classes of textiles, etc.

A manufacturing plant may lie in either or both of these classes. The establishment of a manufacturing program is a radically different process in the two cases, and in the case of the plant manufacturing both for stock and to order the establishment of the program depends upon which class of work predominates.

The establishment of a program of manufacturing for stock depends first upon the probable demand for the product. The analysis of this probable demand is a function of the sales department. The accuracy with which this department can forecast this demand is a measure of its efficiency. It is not within the scope of

this paper to discuss the methods of sales analysis, but it may be pointed out that in general they should be based upon the same broad principles of preplanning and exact knowledge of the problem as form the foundation of production management.

The analysis of probable sales should show for the purpose of establishing a manufacturing program:

a The total demand for the product during a given period of time. This period should be as long as possible, and preferably not less than six months.

b Whether or not this demand will be at a uniform rate. If not uniform it should show.

c The variation in demand from month to month, or even for shorter periods if possible.

With these data before it, the management may then plan the productive activities of the plant so as to meet this demand in the most economical manner. Fig. 1 is a graphical presentation of a sales analysis and the resulting production program. Curve *A* represents the expected sales, month by month. Curve *B* shows

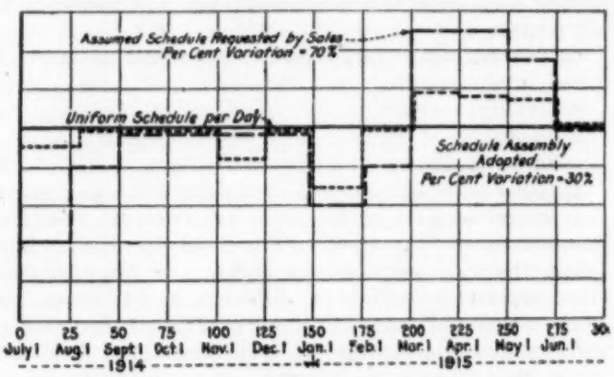

Assumed Schedule Requested by Sales
Per Cent Variation = 70%
Uniform Schedule per Day
Schedule Assembly Adopted
Per Cent Variation = 30%
0 25 50 75 100 125 150 175 200 225 250 275 30
July 1 Aug. 1 Sept. 1 Oct. 1 Nov. 1 Dec. 1 Jan. 1 Feb. 1 Mar. 1 Apr. 1 May 1 Jun. 1
1914
1915

Fig. 2—An automobile manufacturing schedule

these monthly sales accumulated to give the total sales at any time after the beginning of the sales program. Curve *C* shows the production program month by month, and Curve *D* the monthly production accumulated to show the total production at any time during the program. Curve *E* is the inventory. The production program should be so laid out that the inventory will never fall to zero. Another curve might be added to show the actual total production in comparison with the planned production. If the production management, however, is efficient, this curve would fall exactly upon Curve *D*.

It will be noted that the monthly production program does not follow the monthly sales program. The reason for this in the case at hand is that there is always a minimum size of lot that it is economical to put through the plant, and this minimum may be larger than the expected sales at the beginning and end of the program. Furthermore, the expected sales at the middle of the program are greater than the manufacturing facilities of the plant, and provision must be made for these by building up the inventory during the early part of the program.

The establishing of uniform manufacture with a minimum amount of labor turnover, and at the least cost, is largely dependent, in an industry where sales vary from month to month, upon the starting of the manufacturing program for a given sales program at the proper time. This proper time is such that sufficient units of product will be built ahead of the sales peak, so that the sales peak will reduce the accumulated product to a normal or predetermined inventory. There may be cases where this slow increase of inventory must be started several months in advance of the peak, for the further away from the peak the accumulation can begin, the less will be the disturbance created by the peak, and the maximum possible operating efficiency will result. A graphical analysis of this character will give a clearer idea of the manufacturing problem than any other presentation.

The rate of production having been decided, the next decision to be made is the size of the various lots of product that must be put through the plant, and the intervals at which these lots must be started in order to meet the production program. These decisions having been made, the production follows the routine described later.

The production program should be analyzed with reference to economical utilization of personnel, as well as for production according to a sales program. If the final product is composed partly of parts made in the factory, and partly of outside purchases, the schedule of deliveries of the outside purchased parts may be scheduled to conform to the sales program, while the production of manufactured parts is maintained at a uniform or nearly uniform rate.

Such a schedule as laid out for automobile manufacture is shown in Fig. 2. The sales program shows a variation of 70 per cent. The schedule of assembly adopted to meet this variation shows a variation of 30 per cent. The schedule of production of manufactured parts is uniform and has zero variation. Analysis of the product developed the fact that 60 per cent of the cost of materials entering the final product was contained in 59 out of 1,330 parts. Of these 59 parts, 44 parts, representing one-half of the cost of material, were purchased finished parts which did not enter into the production schedule until the final assembly. The balance of the other parts entering the car represented such a small relative material value that it was possible to operate the productive labor manufacturing parts on a uniform schedule. The final assemblies, however, were made according to a variable schedule as shown in Fig. 2.

In arranging the variations of the assembly schedule, a variation in labor of not more than 30 per cent was

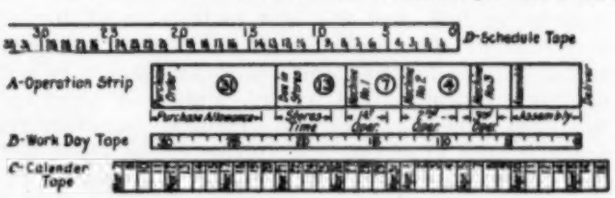


Fig. 3—The principle of graphic control

permitted; i.e., not over one man in every three on the assembly force was allowed to be changed, two-thirds of the force thus consisting constantly of trained men. The cars were assembled according to the assembly, as shown in Fig. 2, and the high-cost materials noted above were ordered for delivery to agree with this schedule. The capital invested in inventory was thus kept at minimum, both for purchased and manufactured parts.

Several factors enter into the determination of the most economical size of lot to be used in manufacture. The first and most important factor is previous experi-

ence with similar product as a general guide. The following specific considerations must be taken into account:

Small lots are indicated by:

a High cost of material.
b Large unit bulk of material.
c Long time required for various operations on a part.
d Probability of change of design.
e Reduction in inventory.
f Conservation of floor space.
g High unit weight of material.
h Use of perishable materials in processes.
i Early entry of part into sub-assembly.

Large lots are indicated by:

a High average cost of machine set-ups.
b High dispatching, inspection and trucking charges.
c Rapid production even with elaborate set-up.
d Reduction of spoilage.
e In general, all preparation charges should be satisfied with largest possible lots.

A number of formulas have been prepared at one time or another for the mathematical determination of lot sizes. The more accurate of these are based upon material cost per piece, time required for operations, interest charges on material in process, rental charges for space occupied, wage rates, etc. Accurate formulas, taking all these facts into consideration, lead to cubic equations which are difficult of solution. The author has found it preferable to determine lot sizes by trial and error rather than by applying a formula.

A plant manufacturing to order obviously cannot plan its production in advance of the receipt of orders. Preplanning in this case involves only the analysis of the order to determine the material that must be purchased and the time required to procure it, and to determine the operations that are necessary, the sequence in which they shall be performed, and the time at which they shall start in order to meet the delivery date specified in the order. These determinations must be made with reference to orders already in process, and the new order must be fitted into the manufacturing schedule in such a manner as not to create disturbance. The purchasing is often simplified by the fact that most manufacturing concerns of the class under discussion operate in a somewhat limited field as regards product, and the raw material used for all orders is of the same character. Thus a company specializing in hoisting and conveying machinery will use for practically all of its orders pig-iron, sheet and bar steel, alloys and certain standard manufactured products such as rivets, bolts, pillow blocks, chain belt, etc. These it will keep on hand in sufficiently large quantities to fill its requirements over a certain period, purchasing in large lots whenever the stock falls to a predetermined minimum. If the analysis of the order shows that there is sufficient raw material available to fill it, production can begin at the earliest date on which machine capacity is available.

Another class of manufacturing which is to order, but which has many of the characteristics of manufacturing to stock, is found in certain phases of the textile industry. In the manufacture of woolen fabrics for dress goods, orders are taken by means of samples for varying quantities of product of different grades and patterns from numerous customers. The small orders for each fabric are combined into single manufacturing orders, from which a manufacturing program is built up. Since the samples are sent out and orders taken before the manufacturing season starts, the mill is enabled to plan a production program in its entirety before actual production begins.

Where manufacturing for stock predominates, the stock program is laid out as heretofore described, and the product made on order is fitted into the stock program. This may be accomplished by ascertaining what proportion of the machine capacity is not utilized over a given period for stock manufacture, and then scheduling the special product through this excess capacity as if the balance of the equipment did not exist.

Where the stock production is of minor importance, it is scheduled on the basis of the excess machine capacity available. In doing this, if the stock program extends beyond the time for which special orders on hand will utilize the equipment, care must be taken to reserve sufficient capacity to handle future special orders. The capacity so reserved should, in general, be equivalent to the capacity required for special work during some definite preceding period, say from one to six months.

In purchasing material these considerations must be taken into account:

a Quality.
b Price.
c Time of delivery.

Quality is important, especially where the final product must meet specifications as regards strength, durability, etc. It is also important in that it may affect the time required for completing the processes in manufacture, and if of different quality than that upon which the manufacturing program is based may require much more time at each operation. The program then cannot be carried out as planned, except at the expense of overtime or the utilization of more machinery and men than were contemplated. It is poor economy to substitute material of unknown quality for that of proved quality to gain a slight advantage in price.

All things being equal, the lowest priced material is to be desired. If, however, the quality is lower, or delivery cannot be insured at the desired time, price becomes less important than other considerations. The time required for delivery is extremely important in laying out a manufacturing program. Since production cannot begin until there is material upon which to work, ample time must be allowed in which to procure material. It is advisable to tabulate the maximum and minimum number of days required for each item of material that is commonly bought, as a guide in placing orders. The reputation of the seller for keeping delivery promises should also be considered, and preference given to the one who can be relied upon, rather than to one who will promise a prompt delivery but whose promises are unreliable. It is better to accept a later delivery date, with the knowledge that it will be met, than an earlier date where there is reason to doubt that delivery will be made on that date. Another factor to be considered is whether the material shall be bought from the mill or from a warehouse or jobber. Purchases from the mill usually cost less, but the time required for delivery is longer. Whenever possible, mill purchases are advisable.

It should be borne in mind that the shortest time required for the execution of a manufacturing program is the longest time required to procure any item of

material plus the time required for the longest process through which that material must pass. The importance of accurate forecasts of the time necessary for purchasing is thus evident.

In the routine of establishing a manufacturing program, then, the first item is to ascertain when the first orders for material must be placed. To do this it is necessary to work back through all the processes of production, starting from the time when the finished product must begin to leave the factory. The methods of doing this are explained later. This analysis of the operations fixes the time at which the material for each process must be available. To this time is added the length of time necessary to obtain prices and secure delivery. Having thus fixed the number of days that must elapse between placing the order for material and the completion of all the manufacturing operations, exact dates can be set for the beginning of each event in the production program. This is known as scheduling.

In making a schedule for manufacturing, the completion of the final operation is the starting point. The number of days that must be allowed for each standard lot or operation must be ascertained. The length of time that must be allowed between operations for movement of material, for inspection, for seasoning or for any other purpose whatever also must be determined. These various intervals are then to be added progressively to show the number of working days prior to the date set for completion of the first lot of the product that each operation should begin. Then by means of a calendar, from which Sundays and holidays are omitted, the actual calendar dates for these operations can be fixed when the date of completion is known. Table I is an example of the fixing of the calendar

TABLE I—PRODUCTION SCHEDULE FOR CYLINDER OF TRACTOR MOTOR

	Finished Tractor	Assembly	Machine Shop	Rough Stores	Purchase	Engineering
No. of days in department	0	22	24	17	60	10
Working days ahead of completion	0	22	46	63	123	133
Date work should be finished	July 1	June 5	May 7	Apr. 7*	Feb. 7†	Jan. 25

* Date on which invoice should be paid.
† Date on which purchase order should be placed.

dates for the principal events in the production of a cylinder for the gasoline motor of a tractor, deliveries of which are to begin on July 1.

This cylinder is a machine shop product, on which many operations are performed. The actual working schedule would show in detail every operation, and the date at which that operation should begin. Several ways of doing this are in common use, and each one has its advantages. No one method can be said to be the best, for the reason that the method to be adopted should depend on the circumstances surrounding its use. Two methods that have proved very successful may be cited.

The first uses what are known as route sheets. One route sheet is used for each item of product, and lists every operation in its order through which the item is to pass, together with the machine, and the date on which the operation is to be performed. Progress of the work is noted by checking off each operation as it is completed. When an operation is checked off the orders for the next operation are issued on the date set opposite that operation. The route sheet may be used for large quantities or for single piece orders.

The second method is semi-graphical. Consider for a moment a single item of product that is made up of many parts. If a horizontal line is divided according to scale of working days, it can be made of such a length that the number of days represented by it is the total time from the completion of the design to the delivery of the final product. Then the schedule can be laid out by noting on this line, according to the scale of working days, the number of days prior to completion that each operation shall begin. The time required for this operation may be shown by blocking off on the line a distance equal in length to the space representing the number of days required. This space is laid down from the point denoting the beginning of the operation toward the point representing the completion of the product, known as the zero point. Another scale, also graduated to the same scale of working days, but reading from right to left in calendar dates, with Sundays and holidays omitted, is then laid along this line of operations, with the date set for completion placed on the zero point. The calendar date on which any operation should begin may be read directly on this scale. If for each item that enters into the final product a similar horizontal line of operations be laid out, there is presented a graphic picture of the production schedule for the entire product.

Control of the Production Program

Such a graphical schedule may be used to control production by the addition of another scale, equal in length to the total time shown on the schedule for the part requiring the longest time. This scale is graduated to read in items of finished product, and is numbered from right to left, from zero to the total number of items in the program. This scale is movable, and at the beginning of the program is set with its zero at the extreme left of the schedule, and corresponding to the first operation shown. It is moved to the right each day a distance equal to one day on the horizontal scale. Whenever the zero of this moving scale passes over any operation posted on the schedule, it is an indication that that operation should begin. The necessary orders should then be issued for such operation.

Progress of the production program can be recorded by writing over each operation in terms of units of final completed product, the quantity of product that has passed through it at the end of any period of time. If the number so written corresponds to the number immediately over it in the moving scale or schedule tape, the operation in question is in accord with the schedule. If the number is greater than that on the schedule tape, the operation is ahead of schedule. If it is less, the operation is behind schedule. The number of days that it is off schedule is ascertained by locating on the schedule tape the number corresponding to that written on the operation, and noting on the scale of work days the interval between the position of this number and the operation in question. (See Fig. 3).

This method is the basis of control boards that have been used to control operation in repetitive work, where the product is put through in lots, as in the automobile industry. If it is desired at any time to increase the schedule, this may be done by decreasing the time interval at which lots are started in the factory.

The route sheet and the control board are adapted

to industries where the product is made up either of single pieces or of a large number of parts that are assembled into a final product. Where the final product is not an assembly, such as cloth fabrics, or where it is an assembled product made in such large volume that the manufacture of each part is on a progressive or continuous basis, scheduling is determined by the speed of the final operation. This determines the amount of product that can be produced per day, and the purchase of material is arranged so that there will be daily supplied to the factory equipment an amount equal to the daily production. The only date to which much consideration must be given is the date on which the first purchase order must be placed. This is fixed by the time required for process up to the final operation plus the time required to procure material. After the flow has once been established, the operations become automatic in their relation to one another. In certain continuous processes, the speed of production is governed by the speed of conveyors which transport the work in process from one operation to the next. If it is desired to speed up the schedule in such a case, it is done by increasing the speed of the conveyors, or by decreasing the intervals at which material is delivered to them for the first operation. Additional machine capacity must then be added at each operation to take care of the heavier flow of work.

Operation Analysis

It is evident from the discussion on scheduling that an important feature is exact knowledge of time required for each operation. It is not enough that the time for an operation by the method in common use be known. For the most efficient management, the time of the best method should be found. This includes both the best method of performing each individual operation and the best sequence of operations.

A prerequisite to efficient scheduling, then, is an exhaustive analysis of each operation to discover the best method and equipment for performing that operation. This also should include an investigation to discover and eliminate all causes that will hamper production, and to standardize the conditions under which production shall be carried on.

For instance, in machine-shop work there may be several methods available for performing a single operation. Boring and turning may be done, for example, in a lathe, a boring mill, or a turret lathe. Considerations that govern the choice of the particular machine in this case might include the size of the work, the number of pieces to be made, the quality of finish demanded, the relative time by each method, the number and cost of special tools, and the time required to set up each machine for the operation in question. The analysis should determine, first, the method, and next standardize the conditions of using that method. In the machine shop, the shape of the cutting tools has a marked effect on production. It is highly important therefore that these be standardized, and the same shape and method of heat treatment be used for the same work every time that it occurs. The best combination of speeds and feeds should also be ascertained for each job, and the workmen should be required to use these combinations. The machines themselves should be standardized so that identical work can be done in machines of the same class. If this is not done, there may be a congestion of work at some machines while others of the same class are idle because they are less efficient than the others. Or if the work is routed to these inefficient machines it may not be possible to do it in the time allowed in the schedule, which should be based on the best method. The schedule may thus be upset at these machines with disastrous results so far as controlled production is concerned. Standardization is a great aid to simplification of routing and scheduling.

Similar considerations obtain in other industries. In the textile field, for example, the speeds of spinning frames and looms on the same class of work should be standardized, otherwise the production will become unbalanced due to one operation producing more than the next can handle.

Uniformity in quality of material is an important factor in scheduling. In the analysis of a job a certain standard of quality is assumed, and all time estimates are based on this. Variations from this quality may seriously affect the time of operation. Thus in the machine shop, a certain grade of iron castings can be machined at a certain best combination of speed and feed with a certain depth of cut. If the casting actually furnished is harder than that used as a basis, the speed or feed must be decreased or more cuts taken than were contemplated. In any event, the time required will be greater and the schedule will suffer in consequence. In textiles, insufficient strength in the yarn due to improper blending of the raw material may cause frequent breakages of yarn, resulting in a shutting down of the machine with consequent loss of time, or in defective product.

Uniformity in quality can be insured as a rule by rigid inspection of raw material accompanied by tests to determined quality. All the material not up to the standard set should be rejected.

Time Analysis

The time required for an operation can be ascertained in a number of ways. Time study is one. Estimation, based on similar work or on previous performance is another. In work where the machine has a definite output per unit of time, as in a spinning frame or loom in textile work, the time is a matter of calculation, based on the quantity of material to be handled and the speed of the machine, with a certain percentage added to cover unavoidable machine delays, and the setting up of the machine. In machine-shop work, where the time required for handling the work and for setting up the machine is relatively small, compared to the time actually required for cutting metal, calculation based on feed and speed and the dimensions of the work, plus a percentage of flat time allowance for handling, etc., may be sufficiently accurate.

While it is desirable, of course, that the time allowed for an operation be as accurate as is possible, it is unwise to strive for absolute perfection when the advantage to be gained is small, and the cost of the last few per cent in the perfection scale is high. Thus, if the handling time on an operation is two minutes, and the machine time 30 minutes, an error of even 25 per cent in estimating the handling time will make an error of only about one per cent in the total time of the operation. The actual length of the job, however, must be considered, in deciding whether or not the error due to estimating will be serious. In the case just considered, an error of 25 per cent or one-half minute per job, would amount to but 7 minutes per day, since less than 16 jobs are all that are possible in an

eight-hour day, and the maximum difference in production would be one piece per week. If, however, a job requires but three minutes with a handling time of one minute, an error of 25 per cent in estimating handling time would be more serious. The difference in product would be one piece per hour, or eight per day.

Time study has not the same relative importance that it held at the beginning of the movement for better industrial management. Several reasons for this exist. In the first place, an enormous amount of time study data have been accumulated and published. These data cover the smallest elements of the work to which they relate, and by combing these elements the time for the great majority of operations can be predetermined with considerable precision. Another reason is the standardization of equipment. Formerly hardly two machines designed for the same work were alike in their characteristics. At the present time there is a remarkable similarity in the characteristics and capacities of machines of the same class, even when built by different makers. Then, too, improvements have been made so that the time for adjustments and manipulation is much reduced, and as a rule, forms but a small fraction of the total time for operation. Machine capacity for a given job can be determined from tabular data or by calculation, aided by slide rules if desired, and in most cases, the machine time is the most important factor. There are many things to be done in the line of standardization, establishment of material control, etc., before a factory is ready for time study. And as Mr. C. G. Barth has aptly said, "When these things have been done there will be little need for time study."

Stores System

The stores system is an important feature of production control. Unless there is an adequate supply of material available when and where it is needed, the most elaborate system and the finest equipment will fail of their purpose. The stores system includes the storage of material and the accounting for it. The accounting system should be so designed as to show at all times the quantity of material of each class and size actually on hand in the store room, the quantity on order but not yet delivered, the quantities apportioned to or reserved for various orders not yet in process, and the particular orders to which these quantities are assigned, and the balance that is available for future orders. The stores ledger sheets should also show the location in the store room of every item carried, and the unit value of these items. This last feature enables inventory to be taken directly from the stores ledgers without the necessity of a physical inventory in the store room.

In the store room, each commodity should carry a bin tag, on which is entered the quantity of material in storage. Additions to the quantity on hand should be entered on the tag, and added to the total already entered. Material issued should be deducted from the bin tag total and a new total brought down. The total quantity shown on the bin tag should always correspond with the quantity shown as on hand in the ledgers, and frequent comparisons should be made to detect errors.

No material should be permitted to leave the store room, except on the authority of a stores issue order, signed by some one with the necessary power. Neither should material be received unless accompanied by the necessary documents to show its origin. These, as well as the stores issue orders, should pass through the hands of the stores ledger clerks to insure that the ledgers will be kept up to date.

Except in continuous or progressive manufacturing, dispatching is essential to make preplanning effective. Dispatching is the assignment of jobs to machines or workmen in the sequence and at the times determined by the schedule established in advance. Under modern management, the foreman or overseer has no authority to dictate when or where any operation shall be performed. The time of its performance is fixed by the schedule, and the place by the job analysis. Work orders then are prepared for each operation shown on the schedule and filed according to the schedule dates. Each day the orders for the day are issued to the workmen concerned. If the work called for by any work order is not available, due to previous operations being incomplete, the order is marked in some manner to make it conspicuous, and pressure is exerted until the work is once more on schedule. Dispatching thus may be performed by a well-trained clerical force and foreman relieved of routine. By noting on them the time of issue of work orders, and the time of completion of work, the dispatching may be used as the time keeping system of the shop and also used to accumulate data for the cost accounting.

Inspection Maintenance Forms

Inspection under modern industrial management is used to prevent defective work, as well as to discover it in completed product. Defective product results only from the two causes of defective material and poor workmanship. The inspection function can be arranged to prevent both of these causes. Inspection of incoming material has already been discussed. As a preventive of poor workmanship, inspection should take place at the beginning of a job. The inspector should ascertain whether the product at each operation is being made according to the specifications, and if not, point out the cause of variation He should not leave until the workman has produced and is producing perfect work. The dispatching of work should include the directing of the inspector to operations that are just being started.

This inspection of work in process should not operate to dispense with final inspection of each part of the product after the last operation. In final inspection, the inspector should be advised as to just what faults or variations from standard are to be looked for, and the permissible amount of variation. The provision of a definite routine for inspection will render it more efficient and less costly.

Maintenance and repair form an exceedingly important function of production management. The duties of the maintenance department include the repair of equipment that fails or wears in service, and the establishment of a system of inspection and preventive repair that will remove causes of failure or make adjustments for wear before failure occurs.

Failure of equipment in service has many disadvantages. Not only is there the cost of repair, but also the wages of idle workmen while repairs are being made, and the loss of profitable production. Constant machine failures will prevent any schedule being laid down with the certainty that it can be met, and production control may become difficult if not impossible.

The maintenance department can avoid all or nearly all of these difficulties by establishing a routine that will insure inspection of the equipment of the plant

at regular intervals. When conditions are revealed that require a remedy, arrangements can be made for the necessary repairs outside of working hours or at a time when they will cause the least interruption to production. It is worthy of note that those plants that have a highly developed maintenance system seldom have equipment failures.

To carry out the routine of any system of management, certain forms are necessary. The system of forms should not be confused with the system of management. The latter is an organized scheme for obtaining certain results, based on definite principles. The former is simply the mechanism provided for the latter. And let it be stated here that scientific management is not a particular system, nor a set of forms. These are but a means to an end. They represent only the easiest and most economical method of applying the principles of management to the case in hand. Two plants may have entirely different systems and their forms may be totally unlike, and still both plants may be truly representative examples of scientific management. Forms are merely a permanent statement of the wishes of the management in regard to the matters to which they relate. They replace orders and instructions that in the early stages of an enterprise or program are given by written memoranda or verbally. When an order or instruction is repeated sufficiently often to warrant it, a form is devised to convey the same information, concisely and definitely, leaving only the necessity of writing in the figures, dates and symbols to make the form complete. Forms may also be considered a delegation of authority to the individual authorized to issue them, the authority, however, extending only to the subjects covered by the form.

Machining Heavy Steel Plates for Punch Presses

By Arthur L. Greene
Buffalo Forge Co.

THE machining of the side plates used on a combination punch, shear and bar cutter machine must be carefully done. Precision is of the utmost importance. The necessary operations include straightening, burning, aligning and checking, together with their attendant difficulties. The material is, of course, of exceptional toughness and thickness.

The finishing of these plates is a highly specialized procedure and may be classified as follows: layout, drilling for cutting, burning with an oxygraph machine, rough-straightening, rough-planing, finish-straightening, checking layout, finish-planing. In addition, the assembling of the two plates must be included, together with the boring and reaming operations.

Not to be overlooked is the need for obtaining steel of the proper metallurgical analysis. The manufacturer guarantees the plates in the finished machine to have a tensile strength of 70,000 lb. per sq.in. To insure the quality necessitated by this guarantee, a critical inspection is given the plates during the machining process for any development of defects.

Properly included in the preliminary operations is that of the layout. Locating points are placed on the plate and a longitudinal and horizontal center line drawn between them. This done, a templet is used for locating the points of the frame.

However, when a machine varying in size from the standard is ordered, the templet cannot be used and the time required for the layout is considerable. The center lines are relocated after the rough-planing operation by means of a small hole drilled at each end of the lines and extending below the finished surface. the need for relocating these lines is apparent. After the planing and burning operations, in which approximately 25 per cent of the original plate is removed, the direction and force of the stresses and strains in the plate have been changed. A distortion of the plate that changes the original layout results and necessitates a realignment of the cut-out sections in relation to each other. To secure greater accuracy, two men are employed in the layout work, one actually doing the work with the templet, while the other checks the results. This procedure has been found of value in eliminating errors of a serious nature.

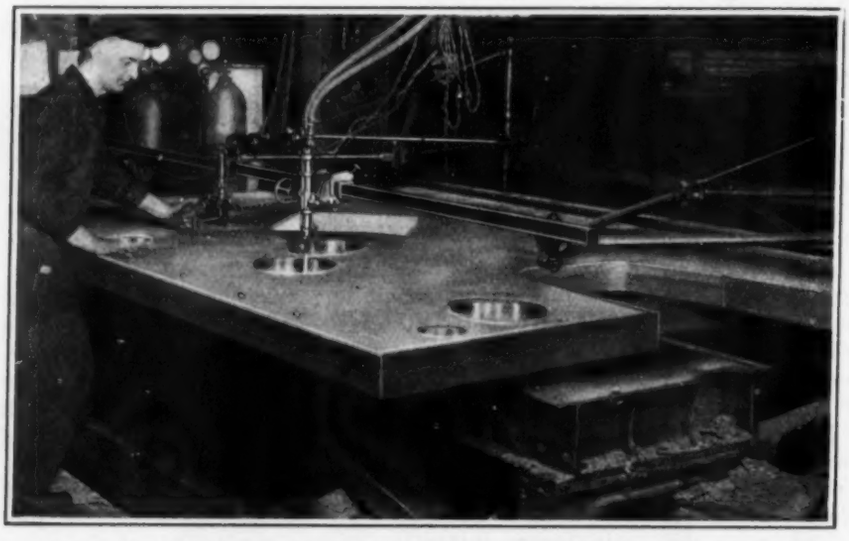


Fig. 1—Cutting openings in 4-in. plate with the oxygraph machine

The drilling for cutting, which follows the layout process, is necessary to permit the cutting machines to penetrate the plate. Holes are drilled for burning out all bearing sections and the square bar-cutter section in the center. Other irregular sections, such as the shearing and punching throats, do not have to be drilled before cutting, as the oxygraph machine will start on an open end. The gas employed is carbo-hydrogen and an oxygraph machine is shown in use in Fig. 1. The rate of cutting with the larged-sized plates is approximately 3 in. per min. The entire time spent in the burning and cutting process on a plate for a large-sized punch, shear and bar cutter machine is estimated at ten hours. This period includes, however, the time spent in handling and

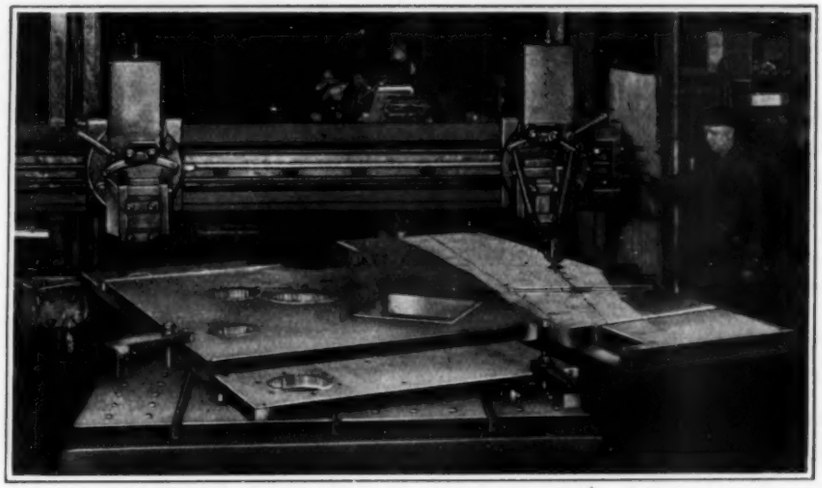


Fig. 2—Planing the slot at the shearing end

setting up the plate. A material inspection of all plates is made immediately following the cutting operation and any defects, such as cracks, can now be easily detected.

A most important preliminary operation is the rough-straightening now given the plate. This is done to eliminate the irregularities in the plate caused by the unequal stresses and strains in evidence after cutting. The straightening method employed is one of peening. The low spots in the plate are found by means of a straight-edge and in order to raise these depressions for planing operations, a bar of steel about 1 in. square is placed beneath the plate and directly under the low spot. The bar is clamped to the plate and an air hammer, in place of the usual hand hammer, is employed for the peening. The length of time required for this rough straightening depends entirely, of course, on the condition of the plate at the time it is received.

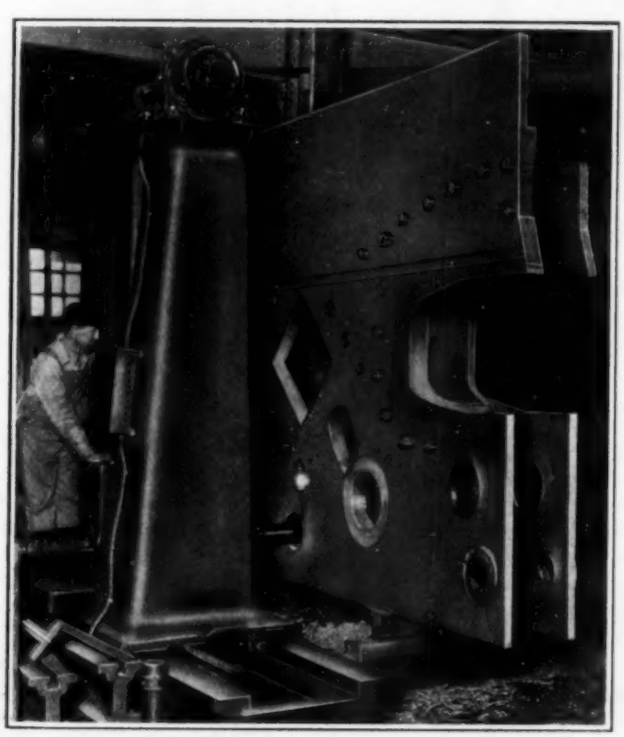


Fig. 3—The final boring operation

The plate is now ready for rough-planing. This is a short process done on a heavy-duty planer. The work includes a cut about ¼ in. deep on both sides of the plate to remove the scale and to eliminate, at the same time, whatever irregular spots may not have been taken care of in the peening process. The slots for shearing are also roughed out in this operation as illustrated in Fig. 2. This first planing operation takes anywhere from thirty to forty hours for completion.

The final straightening process follows upon the completion of the rough-planing. The same method of peening is used here as in the preliminary straightening operation. Before being assembled for boring and reaming, the plates are again checked for errors, and the final planing operation is performed. This final check on the layout is quite essential.

The back plate used on these fabricating machines is generally made of lighter metal, but receives similar

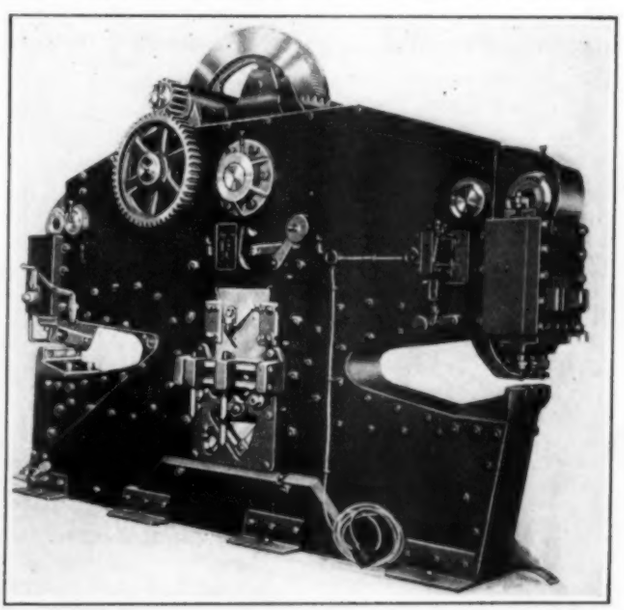


Fig. 4—Completed punch, shear and bar cutter

machining operations. Both plates are now bolted together with the proper spacer between and receive a final finishing planing to insure perfect alignment of all high-pressure bearing surfaces.

The completed frame is now taken to a floor boring mill where the holes are bored for all bearings, as shown in Fig. 3. Care must be exercised here to obtain absolute rigidity of the frame. In addition, the table and spindle must be in perfect alingment to obtain the high degree of accuracy required, and the sliding parts, whether in the spindle or table mounting, must be close fitting. In boring, the bit is fed into the work, as this insures greater accuracy by holding the plate in a rigid and stationary position. All the bearing holes are bored in one setting, thus insuring good alignment. The bearing openings are bored to a press fit for the bearings. Fig. 4 shows a completed machine.

Ideas from Practical Men

Devoted to the exchange of information on useful methods. Its scope includes all divisions of the machine building industry, from drafting room to shipping platform. The articles are made up from letters submitted from all over the world. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for

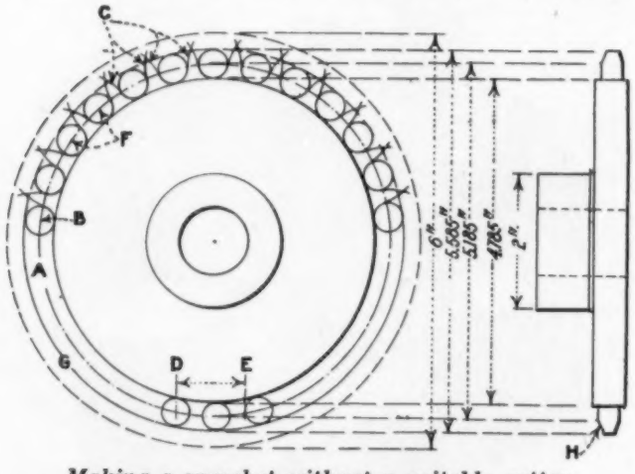
Making Roller-Chain Sprockets Without a Sprocket Cutter

BY GORDON E. ROBERTS

Having several roller-chain sprockets to be cut, some of which were standard and some were not, we were confronted with the ever-present small shop condition of no suitable cutters.

The sprocket in the accompanying sketch is for a chain of ½-in. standard pitch, 0.400-in. diameter of roll and has 26 teeth. The outside, pitch- and base-circle diameters are 5.585, 5.185 and 4.785 in. respectively.

First we turned up the blank, leaving the outside diameter at 6 in., and then coppered the face for the lay-out. We scribed the pitch circle, shown in the sketch



Making a sprocket without a suitable cutter

as circle *A*, and with the dividers set to ½-in. we stepped off 26 spaces along it. At each intersection *B* along the pitch circle we scribed a circle ½-in. in diameter.

Next we set the dividers to scribe the lines *C*, the radius being the distance *D E* in the sketch, thus laying out the top half of the teeth for a distance of five or six teeth.

With a ½-in. drill, the circles *F* were drilled out. This can be done in the milling machine with the blank mounted on a dividing head or it may be done in the drill press. Next, the blank was put on an arbor in a lathe and the outside diameter turned down to circle *G*, 5.585 inches.

With the blank mounted on centers in the dividing head of the milling machine the stock was cut away between the lines *C*, using a standard No. 8, 6-pitch gear cutter. This cutter conforms very closely to the arc *C* of the tooth form.

If no cutter is available, the stock can be cut away with a hacksaw and the teeth filed to line, but by using the 6-pitch gear cutter and cutting one side of a tooth at a time a very nice running sprocket may be made with little hand work.

After the teeth were finished the job was returned to the lathe and the chamfers *H* machined. This sprocket may not be as accurate as one made with standard sprocket cutters, but if reasonable care is exercised it may be made to run very smoothly.

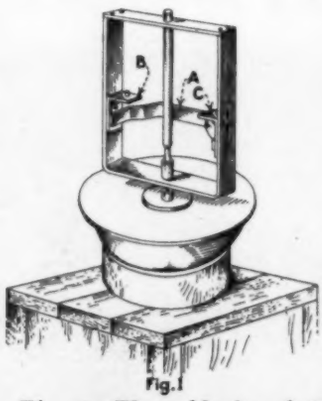
Soldering Fixture for Compass Bowls

BY CHARLES F. HENRY

Soldering is frequently considered a makeshift job and the use of fixtures is not common for the work. When a real job of soldering comes in, the average jobbing shop is more or less at sea as to how to go about it.

The fixture shown herewith was seen in the shop of the Pioneer Instrument Co., Brooklyn, N. Y., and was used in remodeling some of the old, army air-compasses made during the war. The supporting lugs on the compass bowl had to be removed and located in a new position, and all had to be correctly located.

The general construction of the fixture may be seen in Fig. 1. The base is a heavy hemisphere which rests in a wooden cup so that it can be tipped into any



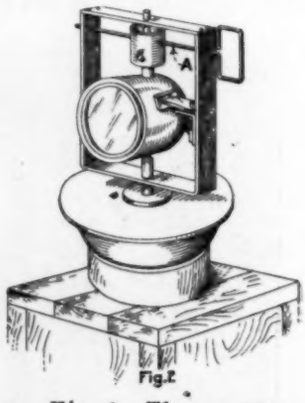


Fig. 1—The soldering fixture Fig. 2—The compass bowl in place

desired position and still be firm for work with the soldering iron or torch. The outer framework carries the crossbar *A* which positions the open face of the bowl, and the ears *B* and *C* with pins, for locating the lugs on the compass bowl.

It is necessary to have the cross tubes for the compensating magnets in the small cylinders in the bowl located square with the face, so the cross wire *A* is put through the frame and through the upper tube as in Fig. 2. At the same time the lugs are located by the pins, which hold them while being soldered to the bowl.

While the fixture will be of little value in any other work the principle can be adapted to other cases.

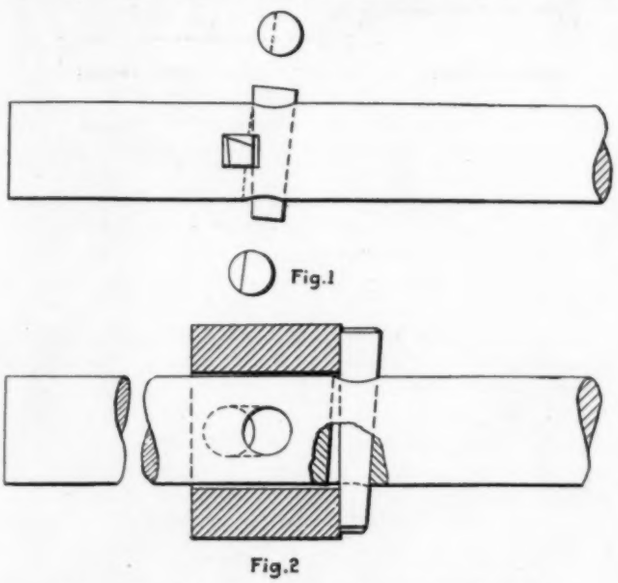
Double-End Cutter for Boring Bar—Discussion

BY F. M. A'HEARN

Referring to the article under the above title by S. Anderson, published on page 667, Vol. 61, of the *American Machinist*, both Mr. Anderson and the editor have left their interested readers in a state of suspense by permitting each to determine for himself whether or not Charles D. Folsom, Jr., was in error when he stated, on page 447, Vol. 60, that the length of the cutter was 1⅛ in. Mr. Anderson embodies his doubt in the form of a question while the editor expresses his belief that Mr. Anderson is right. Mr. Anderson *is* right.

I was sufficiently interested to refer to page 447, Vol. 60, and in order to save other readers the same effort I offer the following:

In next to the last paragraph of his article Mr. Folsom advises that the tool be left a little long for resharpening. This I take as evidence that Mr. Folsom



Figs. 1 and 2—Holding cutter in boring bar

has intended to make the cut approximately an equal depth with each end of the cutter. In this case I will state that the tool must be slightly over 1⅛ in. rather than slightly over 1⅛ in. The metal to be removed from the bore in enlarging a 1⅛-in. hole to 2 in. being ⅞ in. on each side, would make the shorter end of the cutter bore the hole to 1⅛ in., or ⅛-in. radius, while the larger end would bore 2 in., or a 1-in. radius. Thus we have ⅛ + 1 = 1⅛ in. overall length.

I note that both Mr. Folsom and Mr. Anderson seem to secure the cutter by the use of a setscrew. Having used bars and cutters similar to the one under discussion, I suggest the use of a straight round pin, made taper by flattening one side. I have used this as shown in Fig. 1 for small bars, and in some cases where the bore of the hole was several times the diameter of the bar I have used a collar or flange as shown in Fig. 2 to support the cutter well out to the ends.

It will also be noted that in Fig. 2, a round hole is shown to receive the cutter. This makes the building of a boring bar a small job, as the sleeve and bar are assembled when drilled for the cutter, the hole usually being ⅛ in. larger than the size of the round steel to be used for the cutters. The drilling operation completes the tool slot, which may be angled as shown in the illustration if desired.

Simple Tools for an Unusual Job

BY CHESTER H. FRANKLIN

One of the instruments made by the Pioneer Instrument Co., Brooklyn, N. Y., has a case about 3 in. in diameter in which it is necessary to leave a half round depression in the periphery as at *A*, Fig. 1. While it might be possible to draw the case to the required shape if many were being made, it was not to be thought of in this instance, and a very simple and inexpensive method was devised.

The first step was to punch a half round hole in the bottom of the case in the simplest manner possible, using the die *B* and the punch *C*, Fig. 1, for the purpose. Lining up the punch and the die in a small foot press, was the only preparation needed. Fig. 2 shows how this part of the job was done.

One side of the punch was made to the proper radius for the depression to be made in the outside of the case and the other side machined to an arc which just fitted the inside of the case. It was then only necessary to so hold the case that the punch was in contact with the side, and the hole was punched at *A*, Fig. 2.

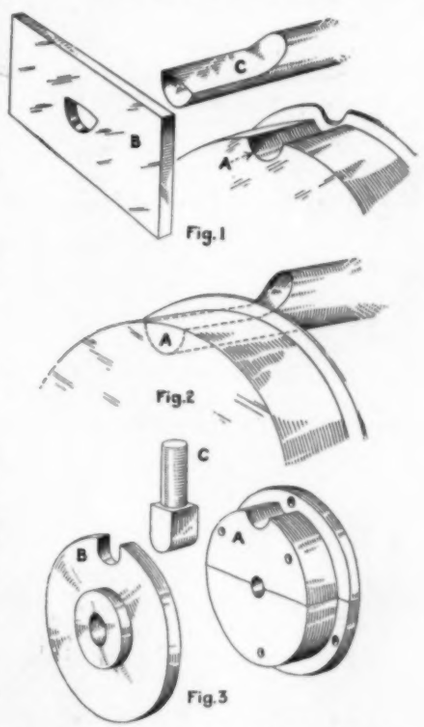


Fig. 1—Punch and die plate. Fig. 2—How the hole is punched. Fig. 3—The tools for forming the case

The next step was to put the case over the form *A*, Fig. 3, so that the hole just punched coincided with the notch in the side. The plate *B* was placed on the back so as to form a wall outside the case, and the punch *C*, made from square stock, was then used to force the metal in the rim down into the depression in the block, and bring the metal at the side in contact with the back of the case. A slight soldering operation on the small arc made the case tight and prevented the entrance of dirt or moisture, which would be detrimental to the working of the instrument.

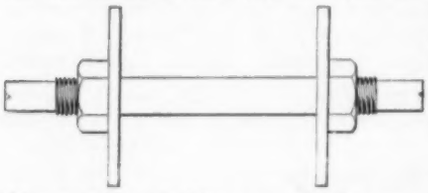
The flat side of the punch acted as a guide between the flanges of the form and the back plate and insured the metal being forced down squarely into the groove. The result was just what was needed at a very slight expense for both time and labor.

Replacement of Driving Boxes on the New York Central—Discussion

BY C. G. WILLIAMS

On page 309, Vol. 61, of the *American Machinist*, there was published an article under the title given above by L. C. Morrow, in which he says "The machining of the brass is done on a slotter."

While I have occasionally seen crown brasses slotted on the outside, this job has only been done thus when a slotter was idle and there was no lathe available on which to do the work.



Mandrel for holding crown brasses

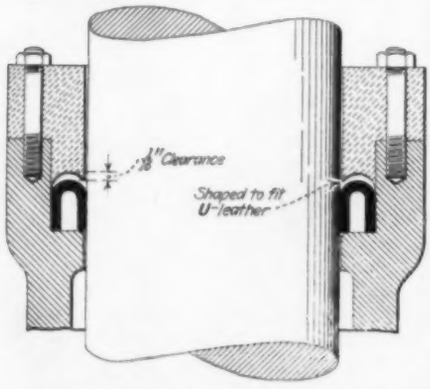
In the majority of shops there is a special mandrel ash shown in the illustration, in which the rough casting is held between the collars for turning. A brass can be turned on the outside in less than half the time that the work can be done on a slotter. I have seen crown brasses turned in 20 min., floor to floor, and they were for what was, in 1923, advertised as the largest passenger locomotive in the world.

The inside or bearing surface is generally machined on a boring mill, because the brass is forced into the box before being bored.

Putting Brass Liners in Hydraulic Jacks—Discussion

BY E. L. PARRY
Lincoln, England

Regarding the practice of putting brass liners in hydraulic cylinders, recently discussed in the *American Machinist*, it is my opinion that the procedure is too expensive. At the same time I cannot see how the method of packing endorsed by Harry Ensminger on page 353, Vol. 61, can be claimed to be a satisfactory job. The condition of having an adjustable gland is one likely to cause trouble, and there is nothing in its favor. The U-leather should always have an upward movement and should never be internally packed. The internal packing defeats the object of the design, which is expansion under pressure.



Leather packing in hydraulic cylinder

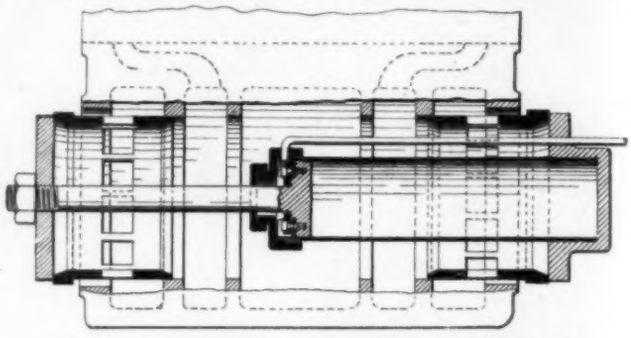
If the gland is machined so as to fit the convex portion of the leather and care is exercised to insure that there is a margin of at least 1/8 in. between the top of the leather and the under surface of the gland, when the latter is screwed down tightly, there will never be need either to fit brass liners or to have recourse to the antiquated method of using hemp packing and an adjustable gland.

The sketch shows the proper way to fit the leather packing.

A Hydraulic Press for Drawing in Valve-Chamber Bushings

BY C. G. WILLIAMS

The illustration shows a hydraulic press designed to draw bushings into the valve chamber of a locomotive. The press was the result of an idea for a mechanical means that would enable us to simultaneously draw both bushings into the valve chamber. The construction of the press was thought out by L. W. Johns, machine foreman of the Hoisington shops of the Missouri Pacific Ry., and designed by the writer.



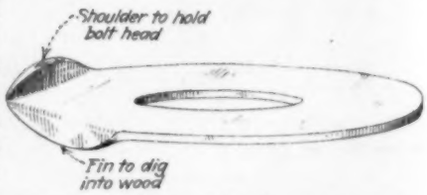
Hydraulic press for valve-chamber bushings

With the press as shown, it is possible to draw both bushings into place in the valve chamber in less than ten minutes, and without heating the cylinder and chamber. This eliminates the danger of cracking the cylinder from heat and the chance that the cylinder might cool too much before the bushings were in place and grip than so they could not be moved.

A Bolt-Holding Washer

BY JACOB WASMANN

When using machine bolts in the construction of woodwork, difficulty is experienced in preventing the bolt from turning as the nut is being tighted. This is particularly the case when the head of the bolt is inconveniently located for the same man to hold the bolt and tighten the nut. As in such work a washer is almost always used, and the simple "kink" shown in the illustration is very effective. The washer is held in a vise and enough of the edge hammered over to form a shoulder for the head of the bolt to seat against. It is then shifted in the vise and a small fin hammered over at a right angle from the first bend and on the opposite side of the washer. This fin digs into the wood and holds the washer stationary, while the shoulder holds the bolt head. In the case of very large, oversize washers, a small hole drilled near the edge of the washer and through which a nail is driven into the wood, takes the place of the fin.



Washer to keep bolt from turning

The Census Figures on Machine Tools

Loss in value of product in 1921 withstood chiefly by expense and profit elements—Machine tool industry poorer in 1923 than in 1919

THE accompanying chart is a comparison, for the years 1919, 1921 and 1923, of the number of wage earners in the machine tool industry, the value of the product, the product per wage earner, and the distribution per dollar of product. The chart was designed by E. F. Du Brul, general manager of the National Machine Tool Builders' Association, and is a part of one of the Association bulletins, of which the following paragraphs constitute an abstract.

It is probable that many firms reported sales rather than the sales value of production. In 1922 there was liquidation of product stocked in 1921. Probably this liquidation extended over into 1923.

Accumulated Capital Reduced in 1921

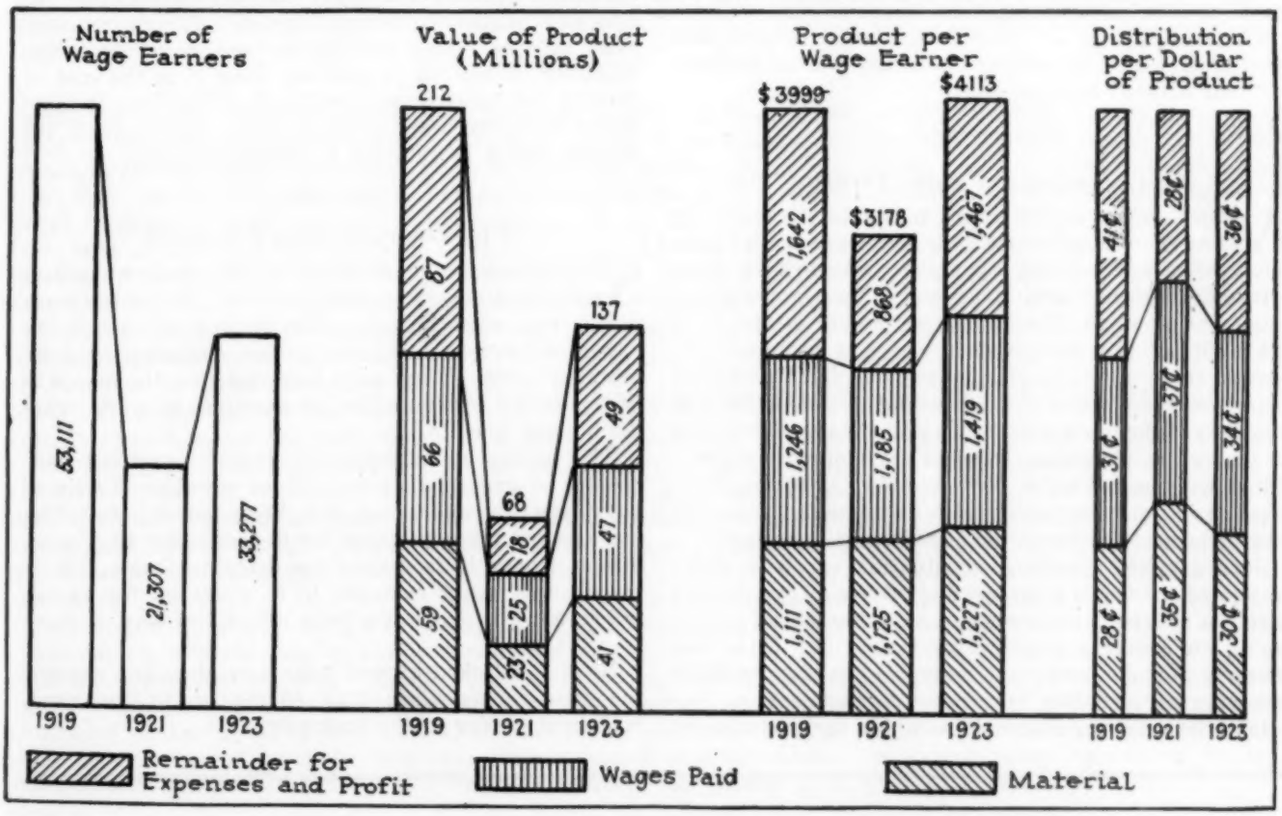
In the set of bars showing value of product it is indicated how the expense and profit elements took the main force of the blow that drove the value of product down in 1921. The relative shrinkage in expense and profit was much more than in materials and labor and the recovery in 1923 was less. Losses of 1921 in excess of the $18,000,000 expense came out of previously accumulated capital. At best 1923 must have been a year of slim profit for the industry.

As shown in the third set of bars, which reduce all the data to a basis of wage earners employed, there was a shrinkage of that base in 1921 of over $800. A little of that shrinkage was paid in wages, but most of it was taken from the "remainder for expenses and profit." It would be interesting to know to what extent this shrinkage was caused by prices made below reasonable costs in an attempt to stimulate the market. Was the loss caused by low production further increased by injudicious pricing?

Materials and Wages Up in 1923

Analysis shows that in 1923 material cost $116 more than in 1919 and wages $173 more, while the remainder was $175 less per wage earner. Out of the higher value per wage earner the machine tool builder got that much less margin and was employing only about 60 per cent of his 1919 force. Net profits depend on the volume of that margin, after paying all expenses. In 1919 that volume was $87,000,000, while in 1923 it was $49,000,000, or 56 per cent of the volume.

As shown by the fourth set of bars the machine tool industry was poorer in 1923 than in 1919. Out of each dollar received it paid more for material and wages but got less for expenses and profits per dollar, and got only 65 per cent of the dollar it got in 1919.



American Machinist
Established 1877
KENNETH H. CONDIT AND FRED H. COLVIN, *Editors*

Research on Grinding Wheels Needed

THERE seems to be a question in the minds of some machine builders as to what subjects are suitable or necessary for research work, or in fact, if such research as has been proposed is at all necessary. And this despite the fact that a long list of subjects for research has been proposed by the University of Cincinnati to the machine tool builders.

Anyone who tries to get information on the subject of grinding must feel the need for both research and standardization in the matter of abrasive wheels. How often do we hear complaints as to the difficulty of securing duplicate wheels, whether of the same make or not. The matter of grinding is far from an exact science and depends for the most part on the skill, experience and state of mind of the wheel grader. There seems to be no exact method of grading available.

When it comes to the nomenclature of abrasive-wheel grades, the user is in deep water. There are three distinct gradings that are used quite extensively and others not so well known. And they bear no more relation to each other than chalk to cheese. In two of the best known lists, *M* stands for medium, but is the only classification in common. While this is a matter for standardization rather than research, it has such a direct bearing on the results to be secured by grinding that it might well be considered at the same time. It is hard enough to secure the same grade of wheel where they bear the same designation without cluttering up a man's mind, or files, with unnecessary complications.

There are plenty of subjects for both research and standardization—the problem is to get started at some of them without further delay.

Governmental Patent Pirating

ALMOST unfortunate situation has been created in some of our government departments in the purchase of machines and apparatus which have been privately designed and developed. The government maintains a patent office for the purpose of establishing the rights of inventors, and in order to encourage invention these rights are made exclusive for a period of years, yet there seems to be a feeling in the purchasing branches of the government that proprietary rights may be ignored at pleasure. In some cases one or two machines have been bought (or borrowed) and from these drawings have been made and bids requested from the competitors of the firm which produced the design.

Such a policy results in a situation which is undesirable when viewed from any angle. We all sympathize with the efforts of the zealous purchasing official who is trying to conserve government funds, but it is bad economy to make temporary savings when they result in removing all incentive to further development.

Occasions may of course arise where the proprietor's price is considered too high, but there is always room for negotiation and few concerns desire more than an adequate return on their investment. It should not be forgotten, however, that the cost of development must be added to that of manufacture. Too often this is forgotten and prices, actually very fair, are condemned as unreasonable.

When a machine or design is good enough to be desired for government use the inventor or designer should certainly be compensated. If no agreement can be reached as to price, or if the designer is not in position to manufacture, it should not be difficult to arrive at a fair royalty figure. Unless some adequate basis for compensation is adopted, we shall find ourselves falling behind other nations, as our inventors, designers and manufacturers cannot be expected to spend their time and money developing new machinery only to have their designs pirated and their machines ordered from other concerns.

What Is Your Production Percentage?

PERHAPS our title here is somewhat cryptic but it has a simple interpretation. We got the idea from a statement made by one of the speakers at the recent A.S.M.E. meeting. Here is what he advised: Go out into your shop or into any other department of your plant and count the number of men you see actually engaged in productive work. Then figure out roughly what percentage of the total force this number represents. It may surprise you.

The advice given looks good to us. We do not infer from it that a low percentage necessarily means an inefficient shop. On the contrary, it may mean just the opposite if men have been replaced by machines to any large extent. In any event it does no harm to check up on the figures occasionally and find out whether the total cost is steadily diminishing even though the overhead may be rising and the percentage of producers dropping. When all is said and done it is the cost of turning out finished work rather than the time it takes to do it or the way in which it is done that is the critical factor in running a production shop.

Why Delay Orders Further?

SHOP managers generally admit that modern machine equipment lowers production costs. Yet in too many cases they wait for the other fellow to install the newer and better machinery before venturing to order any themselves. They seem to forget that the man who first puts the newer and better machines to work, reaps the biggest benefits.

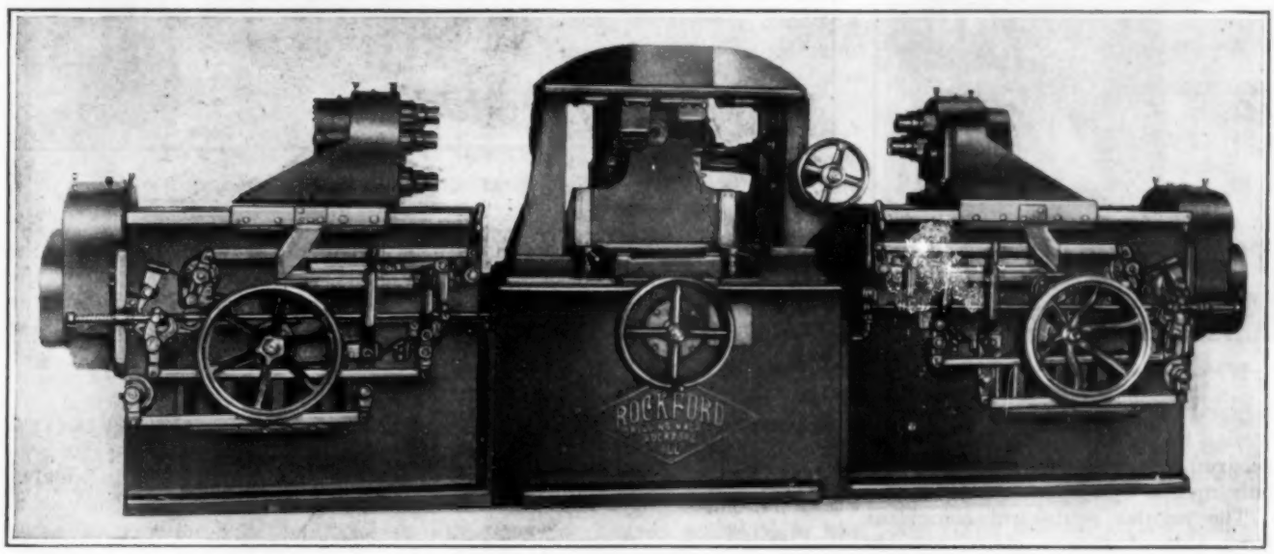
The feeling of optimism for greatly improved business is so general that even those who have hesitated about placing orders can now brace up any faltering courage and place an order for the machines they need. There is very little excuse for delaying longer. It is the duty of every manager to be prepared for bigger orders and for producing them in a better way, if there is one.

Have you looked around your own shop and marked the obsolete machines that should go to the used-machinery dealer or the junk pile?

Shop Equipment News

Rockford Line Drilling and Boring Machines

The Rockford Drilling Machine Co., Rockford, Ill., is now marketing a series of line boring machines adapted for practically any kind of boring operation on a production basis. The particular machine shown in the accompanying illustration was made for core-drilling crank, cam and water pump lines from both ends of a cylinder block, together with the water pump hole from the side.



Rockford Production Drilling Machine

The arrangement of the spindles in these machines can be made to suit the work to be done. Provision is made for motor drive, the motor being mounted inside the base and connected to the drive box through a clutch. This driving arrangement is used so that the machine can be stopped and started without interfering with the continuous operation of the motor.

All drive and feed gears are enclosed in an oil-tight box and are made from heat-treated steel. The control mechanism for drive and feed is located at the front of the machine in a convenient position. The spindle heads are fitted for rapid approach, forward feed and rapid return, together with hand feed in either direction.

Automatic stops control the feeding action at the ends of the traverse and can be located at any point along the ways of the machine. The machines are constructed in the double-end, single-end, or three-way types. A stationary table for one fixture or an indexing table for two fixtures can be furnished. The latter permits practically continuous operation of the machine, the only time lost being that required for the indexing of the table.

The machine illustrated has a mechanical feeding mechanism, the heads being moved by means of a screw and nut. Machines with oil-gear hydraulic feeds can also be furnished when the nicety of control provided by this mechanism is desired. All variations in the rate and direction of the traverse are controlled by a single handle when the hydraulic feed is used.

The machines are constructed in several sizes to suit the requirements of the work to be done.

Wicaco Continuous Oil Groover

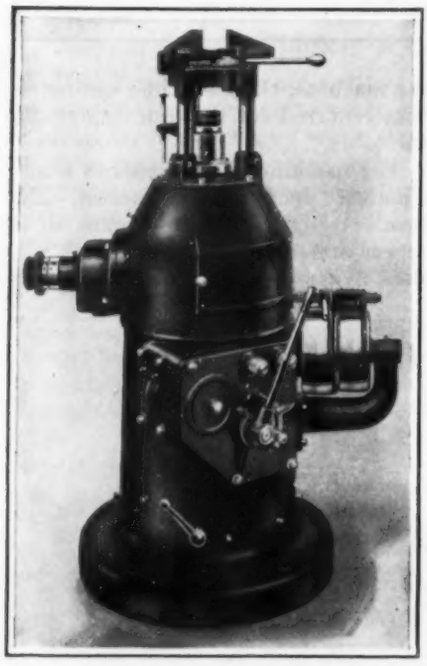
The Wicaco Screw and Machine Works, Inc., Stenton Ave. and Louden St., Wayne Junction, Philadelphia, Pa., is marketing a machine designed for cutting various types of oil-grooves, including straight, cross, and right- or left-hand helical oil-grooves, on internal and external surfaces of parts.

The work-holding chuck is attached to three upright steel posts at the top of the machine. It is of the three-jaw scroll type, self-centering, and operated by means of a handle. Work up to 4½ in. in diameter may be held in the chuck.

Two knurled spring plungers control the movement of the cutter-spindle. By acting on one of them, the cutter-spindle is operated vertically, without rotating; this arrangement permits the cutting of straight grooves and keyways and die slotting, as the tool relieves at any point on the circle. The second plunger obliges the cutter-spindle to rotate and reciprocate, according to the type of groove required.

The stroke of the crank is adjustable from 0 to 7 in. by increments of $\frac{1}{16}$ in. The machine may be driven from a line shaft or by a directly connected $\frac{3}{4}$-hp. motor.

The vertical construction of the machine permits the handling of a larger variety of sizes and shapes of work, as special fixtures can be secured to suit the necessary requirements.



Wicaco Continuous Oil Groover

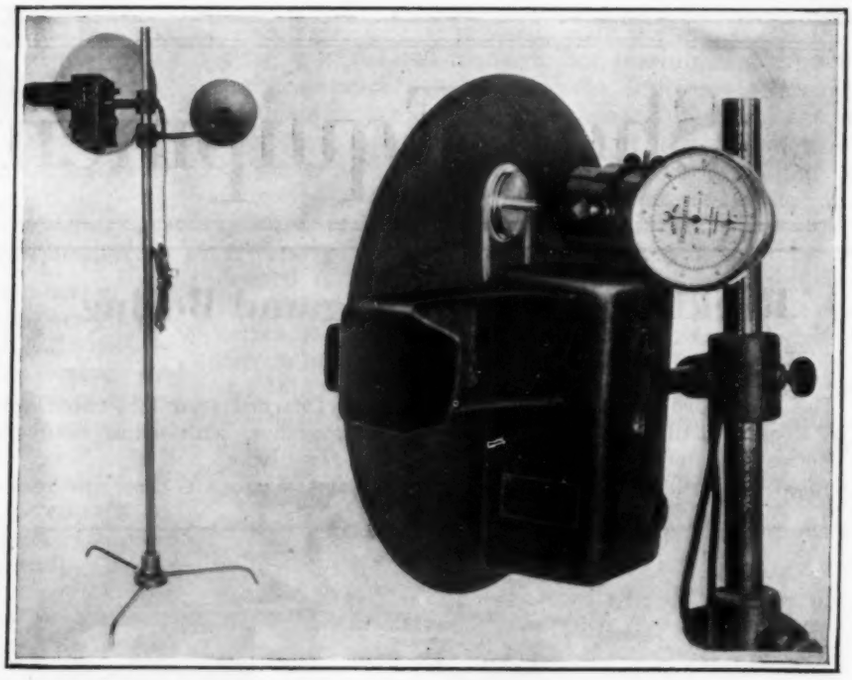
The regular equipment comprises three sets of change gears, capable of cutting grooves as follows: Figure eight, double figure eight and ellipse.

The machine occupies a floor space of 2 x 3½ ft., is about 4 ft. high and weighs 700 pounds.

Attachment for Rotostat Instrument Co. "Rotostat"

The Rotostat Instrument Co., 220 North 13th St., Philadelphia, Pa., has devised an attachment to the instrument known as the "Rotostat," described in the *American Machinist*, Vol. 59, p. 349. This attachment, shown in the illustration to the right of the instrument, allows direct speed readings of distant or inaccessible machinery and machine elements.

The "Rotostat" itself is an instrument by means of which a mechanism, while actually running at full speed, may be made to appear slowly moving or to assume apparently stationary positions. The attachment to the "Rotostat" permits the simultaneous use of a tachometer, giving the actual speed of the mechanism under observation. Thus speeds of overhead line shafts and countershafts may be quickly read from the floor of the shop. The speeds of delicate mechanisms, the velocity of which is affected by the direct application of a tachometer or speed indicator, can be determined accurately.



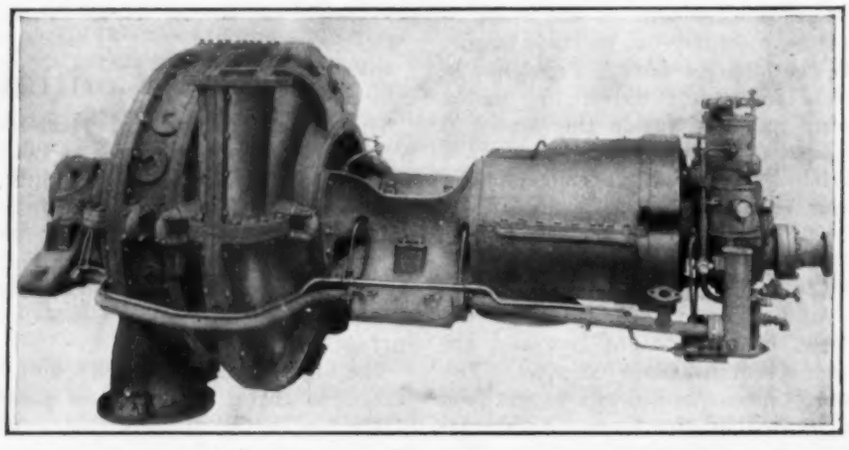
The "Rotostat" without attachment and with tachometer

General Electric Centrifugal Compressors

The General Electric Co., Schenectady, N. Y., is now marketing a line of multi-stage, centrifugal compressors, designed to supplement the line of single-stage machines recently developed.

The compressors will find their greatest applications in those instances where higher pressures than obtainable with single-stage machines are desired, and can be used with advantage in pneumatic material-handling systems, gas exhausters, gas boosters and also in blowing blast furnaces and Bessemer converters and in a number of other cases.

The main line of compressors covers water-cooled machines designed to deliver volumes of from 3,000 to 60,000 cu.ft. per minute, at pressures up to 30 lb. or more. The line will also include two types of miniature, self-cooled machines designed to deliver volumes of from 250 to 1,400 cu.ft. per minute at pressures of



General Electric Centrifugal Compressor

from two to six pounds. All types are to be equipped with either motor or turbine drive.

Each complete unit has four bearings with an automatically lubricated flexible coupling. The machine is provided with governing devices to maintain constant volume, pressure and suction. The bearings are supported by the foundation under the machine.

Stecher Automatic Universal Drilling Machine

An automatic universal drilling machine, especially designed for high-speed drilling operations on small parts, has been developed and marketed recently by the Charles Stecher Co., 2452 North Greenview Ave., Chicago, Ill. The machine, illustrated in Fig. 1, is intended for use as a bench drill and is of sturdy

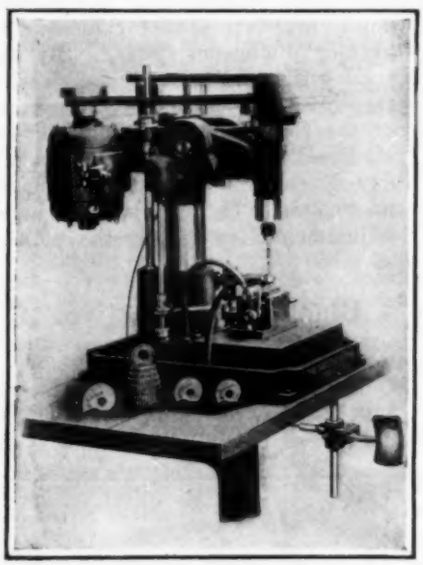


Fig. 1—Stecher Automatic Universal Drilling Machine

construction. It can be used either with power feed or as a sensitive hand-feed machine.

The motor, spindle and feeding mechanism are carried in the head at the top of the column, the height of the head being adjusted by means of a screw and crank that moves the column vertically through a bearing in the bed. A clamping handle provides means for securing the head firmly in the desired position. The wide range of vertical adjustment between the drill head and the base permits the use of a short spindle. The spindle is mounted in ball bearings.

Power is delivered by belt from the motor to the spindle, which in turn operates the feed mechanism, shown in Fig. 2. Three-step cone pulleys on spindle and motor provide three variations in speed. The feeds are regulated through a set of change gears, that can be arranged in combinations to provide a desired speed. A cam mechanism, engaged by a knee-operated control under the bench, feeds the spindle automatically, when once set for the desired height and depth of hole.

Momentary pressure on the knee control releases a positive clutch in the drill head, engaging the feed cam mechanism. The feed cam then makes one revolution, during which it feeds the drill through the work, returns it and stops. When the work can be fed continuously, it is only necessary to apply constant pressure against the knee control to keep the machine in continuous operation. The drill can also be fed by hand.

The feed cams, regardless of size, are all shaped so that the idle travel of the drill to and from the work is at a rapid rate. Three sizes of cams are regularly furnished, each cam being marked to indicate the depth of hole for which it is to be used. A micrometer dial is attached to the head-adjusting screw shaft for use when it is desirable to set the drill in close relation to the work.

A feature of the machine is the automatic jig-clamping device. The device is operated through a vertical shaft connected to the cam feeding device in such a manner that the work is automatically clamped in position as the drill approaches it. The mechanism is pneumatically operated, releasing the clamp automatically as the drill is withdrawn and ejecting the work. The use of a dial, rotary or magazine feeding device makes the machine semi-automatic, the production being limited only by the capacity of the drill.

The spindle, power-feed shaft, idler pulley and motor are equipped with ball bearings, and a ball bearing pump is furnished for flooding the work with the coolant. The pump is driven by the vertical power feed shaft. Special cams, jigs, and other equipment can be furnished.

The base of the machine is 15x21 in. and the table is 8x12 in. The maximum travel of the spindle by hand feed is 1⅞ in., and with power feed, 1¼ in. The vertical adjustment of the head is 7 in. The distance from the center of the drill to the face of the column is 5¼ in. The feed

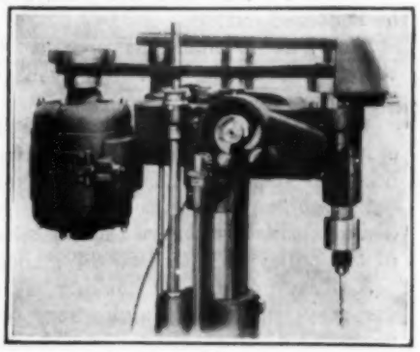
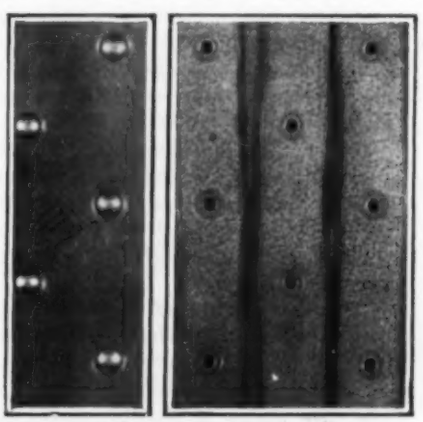


Fig. 2—Cam feeding mechanism

per revolution of drill ranges from 0.0005 to 0.020 in. The maximum speed is 15,000 r.p.m. Power is supplied through a ½-hp. motor, the maximum motor speed being 3,600 r.p.m. The net weight of the machine, complete, is 260 pounds.

Alexander Brothers "Tentacular" Suction Belt

Alexander Brothers, Inc., 14 South St., Philadelphia, Pa., are marketing a special type of leather belting known under the trade name "Tentacular." The illustration shows the outside and the inside of the belt. The outside consists of oak-tanned leather and the inside is composed of narrow longitudinal strips of soft and spongy chrome-tanned leather. The strips are held in position by means of hollow brass rivets which form depressions or pockets in the soft leather. These pockets, it is contended, act as suckers, causing a closer adhesion of the belt to the pulley. A further contention is that the adhesion of the belt is increased,



"Tentacular" Suction Belt, outside and inside

due to the presence of the spongy chrome leather, treated with tallow, and also due to the fact that the spacing between the strips allows any air film, which may be imprisoned between the belt and the pulley, to be squeezed out.

The belt is made at present in three types, of the following average thicknesses:

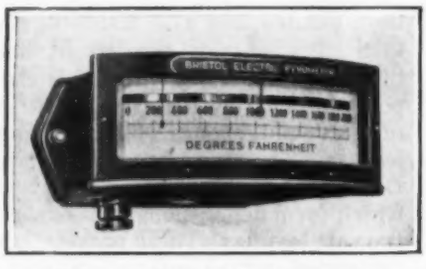
1. Single-ply backing, $\frac{5}{32}$-in. for all drives where the load to be carried does not require a heavier material.
2. Double-ply backing $\frac{11}{32}$-in. for heavier loads and where the diameter of the pulley is not below 14 inches.
3. Heavy double-ply backing, $\frac{13}{32}$-in. for very heavy loads and where the diameter of the pulley is not below 16 inches.

The normal thickness for the chrome-leather strips is approximately $\frac{1}{4}$ in., although thicker material is used for special conditions. Two sizes in the width of the strips are used, $\frac{3}{4}$-in. and 1-inch.

Bristol Indicating Pyrometer, "Model 420"

The Bristol Co., Waterbury, Conn., has added to its line of pyrometers this indicating high-resistance pyrometer, known as "Model 420."

The scale is 7 in. wide and provided with a mirror to eliminate



Bristol Indicating Pyrometer "Model 420"

errors in reading due to parallax. As an aid to easy visibility a combination pointer is provided, having a broad section for distance reading, and a knife-blade section for accurate close-up work.

The measuring element is a high-resistance millivoltmeter. As a part of the standard equipment the instrument is provided with the Bristol automatic internal cold end compensator.

The case is made of cast aluminum. A small adjusting screw on the outside of the case serves for zero adjustments, and a knob on the top of the case makes it possible to set the normal index spotter to the temperature desired for each piece of work.

Haskins Type D B-6 Equipment for Grinding and Polishing

The R. G. Haskins Co., 516 W. Monroe St., Chicago, Ill., is marketing its D B-6 equipment for grinding and polishing.

This machine consists of a heavy pedestal mounted on ball bearing casters with a $\frac{1}{2}$-hp. motor swiveling

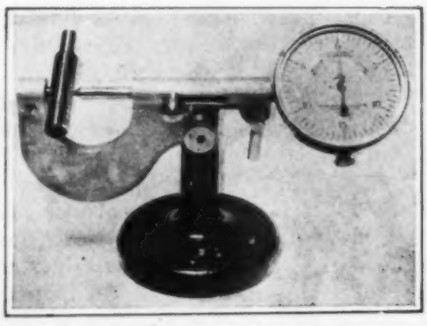
Haskins Type D B-6 Equipment

thereon. The flexible shaft is wound with $\frac{1}{2}$-in. steel wire and revolves in an oil tight casing.

The equipment operates at a speed of 1,750 r.p.m. While it is shown in the illustration equipped with a soft polishing drum, the machine is equally serviceable for grinding and wire-brush work.

Federal No. 45 Pitch-Diameter Gage

The Federal Products Corp., 15 Elbow St., Providence, R. I., has brought out a gage for measuring threads at the pitch diameter. As may be seen from the illustration the



Federal No. 45 Screw Pitch-Diameter Gage

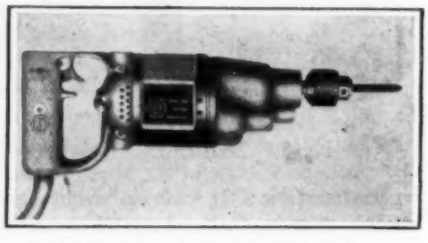
gage consists of a bow-frame with fixed anvil and sliding spindle, to the end of which is attached a standard Federal dial gage.

The instrument is adjustably mounted on a heavy standard, suitable for use on a work-bench. Screw holes in the base of the standard allow it to be permanently fastened in one position on the bench if desired. The gage is one of comparison only, and is intended to be used as an inspection gage to show deviation above and below the nominal size of a standard threaded plug to which it is set before using.

The dial is graduated in half-thousandths, with sixty divisions, giving a range of 0.03-in. to one turn of the pointer. The full range of the dial is ten turns, or 0.3 in. Removable anvils are furnished for measuring various pitches of thread. By adjusting the position of the anvil with respect to the frame the full opening of the bow is available and the instrument may be used to measure any diameter of screw, bolt or tap up to 2 in. The dial has the usual adjustments for setting the pointer to zero.

Black & Decker No. 2 Electric Tapper

The Black & Decker Manufacturing Co., Towson, Md., has added to its line of portable electric tools the



Black & Decker No. 2 Electric Tapper

"No. 2 Electric Tapper." This machine is similar in design and construction to the other electric drills manufactured by the company for certain features.

The mechanism in the gear case is so designed that the tap is driven in at a speed of 350 r.p.m. By a slight backward pull on the machine, the tap chuck is automatically reversed and the tap backed out of the threaded hole at a speed of 700 r.p.m. No reversing switch is needed.

The machine will tap holes in steel up to $\frac{1}{4}$ in., in cast iron up to $\frac{3}{8}$ in. and in brass or aluminum up to $\frac{5}{8}$ in. It is equipped with a universal motor.

News of the Week

Owen D. Young Receives High Honors from Representative Business Men

Nation's leaders laud fine work done on Dawes plan

Owen D. Young, co-author and first administrator of the Dawes plan, was accorded a tribute Thursday evening Dec. 11, at a dinner in the Waldorf-Astoria, New York, seldom given a private citizen of the United States, more than 1,000 leading men in all phases of endeavor lauding him for his rôle in the economic reconstruction of Europe. And when the French Republic, through a representative, invested him with the cross of a Commander of the French Legion of Honor, the leaders of business, standing up for the ceremony burst into cheers.

Responding to the signal honors paid to him Mr. Young said that the Dawes plan, successfully working out, had brought the world to the threshold of a new day of peace and development. But, he cautioned, in the course of a clear discussion of the plan's results, continued and wholesouled co-operation of the American people is needed to maintain the achievements so far gained.

The dinner, arranged by a committee headed by A. C. Bedford, Chairman of the Standard Oil Co. of New Jersey, brought forth for Mr. Young the thanks of foreign Premiers, as well as a message from President Coolidge. Congratulations to Mr. Young came in person from Secretary of Commerce Herbert Hoover, Richard F. Grant, president of the Chamber of Commerce of the United States, and William Church Osborn, who attended the dinner. George W. Wickersham, former Attorney General, presided.

Europe Sends Congratulations

Appreciation of his part in "bringing into effect the valid co-operation of the American people in one of the most important phases of the postwar reconstruction work" was conveyed to Mr. Young in a message from Premier Mussolini of Italy. A similar cablegram from Premier Theunis of Belgium was read, while Stanley Baldwin, Premier of Great Britain, sent Britain's gratefulness for a "fine piece of disinterested service." Premier Herriot of France was another who cabled congratulations.

Vice-President-elect Charles G. Dawes, from his home in Evanston, Ill., sent his meed of praise to his associate saying that "no honor that can be paid him is too high." Utilizing an elaborate telephone and radio network that broadcast all of the speeches, on a scale comparable only to the election speeches of President Coolidge, Secretary of State Hughes telephoned his tribute from Washington, the diners hearing him through the hotel's loud speaker system.

The transmission of the Secretary's voice was remarkably clear, the words issuing in the ballroom almost as distinctly as if the speaker had been at the dias instead of in distant Washington.

Sir Robert M. Kindersley, English economist, banker and business leader, who was associated with Mr. Young in the work of the Dawes Commission, was enabled to convey his appreciation in a novel way. As a tribute to Mr. Young the Radio Corporation of America flashed by radio a reproduction of Sir Robert's message. The recently demonstrated invention of Captain Richard Ranger, used several days ago to transmit photographs and sketches from London to New York, was employed. Within a few minutes after its receipt the message, chirography perfect, was flashed on a screen back of the speakers' dais in the Waldorf.

Secretary Hughes by Telephone

Secretary Hughes, after expressing his regret that he had not been able to attend personally, said over the telephone that he had never doubted that if the way were opened for men "of the highest competence to bring their impartial judgment to the solution of the economic problems of Europe, America would be ready to supply talent of the highest order."

Mr. Grant, in his speech, said that everywhere in this country there was developing a keener sense of intercommunal responsibilities.

"No feeble word of mine can give adequate expression to the gratitude which the whole world owes to Messrs. Dawes and Young and Robinson for their great accomplishment," he stated. "I am honored to have the opportunity and privilege of being present this evening and giving simple expression to my own feelings and convictions. I am very sure that Mr. Young would not want me to say those things which are in my mind and heart, but would rather that I would measure the work he has done in terms of accomplishment. I am very sure that this new sense of ever-widening unity which has found expression in his work is the thing which can save the world, and nothing else has yet appeared upon the horizon which even suggests hope."

Secretary Hoover said:

"The German reparations had become one of the world's most dangerous inheritances from the war. The sequent failures in its adjustment had poured an increasing stream of conflict into international life, carrying with it political jeopardy and economic demoralization with its train of millions of unemployed and suffering.

"The accomplishment of its settlement involved great economic questions of production and distribution, of currency, of credit, of taxes, and of exchange. Solution has been found in denominations of money and goods, in the creation of complex agencies of finance and government. But there springs from the settlement something far greater than the denomination of these quantities and the working of this machinery of government. It has turned millions of men from discouragement to hope. It has revived the forces of courage and enterprise. It has done even more. It has defeated the forces of hate, and advanced the tide of peace in the hearts of men.

Confidence Restored

"While this adjustment primarily advances the welfare of the nations of Europe, it reaches far afield in the world. Unemployment and suppressed production anywhere in the world are in the long view a world loss. This restoration of confidence and hope and enterprise, this restoration of commerce, of productivity, and of employment, this relief of suffering in a great nation, is a world asset. As a people we also participate in its blessings. Some part of our growing demand for labor, some part of the increased prices already realized by our sorely distressed agriculture, have come from this restoration of economic vigor and hope in Europe. It is a great thing to have contributed so much to this achievement.

"The wounds of our complex and intricate civilization from the war were so deep and so vital that many had despaired lest statesmanship would be unequal to their healing. Six years since the armistice seems a long time to those who live it and partake of its anxieties. Six years is a trifle in human history, and yet within it, one by one, these great problems of reconstruction have been solved. Surely in this new accomplishment for which we justly give tribute tonight we see again renewed confidence, hope and faith in human institutions. There are indeed many problems yet unsolved, but none of those before us are as dangerous to the restoration of civilization as those that have already been successfully met in these six years.

"Some have doubted whether the enormous liabilities established under this settlement can be discharged. There are those who have contended

that no great external contributions from one nation to another can be economically sustained. Without debating this question I may be permitted to offer one thought in this connection. The payments provided in such settlements must find their substance from production and economic services rendered. These international obligations are huge burdens, but in the course of years any burden shrinks in weight in proportion as the productivity of a nation grows. When the world keeps peace it doubles its international trade once in nearly every score of years. The advancement of science, of invention, and of industry have shown an unceasing contribution to the productivity of peoples.

MR. YOUNG'S ABILITY

"But beyond even these special occasions of vivid public service, Mr. Young has made a still further contribution to American life—perhaps the greatest of all his contributions. That is in his display of the fine sense of the responsibility which today rests upon those who administer our largest industries.

"Manufacture and distribution on a vast scale is the foundation of our high standards of living and the general comfort of our people. It can be accomplished in no other way than through the development of great units of production. With their development have come innumerable problems of public relationship and public responsibility. We are in fact today witnessing a rapid evolution and perhaps a silent revolution in the relationship of great business to our social system. We are struggling to preserve the fundamental stimulus of action, of initiative and competition, to hold open the avenues of opportunity. At the same time we are struggling to gain the benefits of co-operative action. In this period of evolution nothing is more needed than clear vision of their public responsibilities on the part of our industrial leaders. For here is a triple trusteeship—a trusteeship to the owners who ultimately must be comprised from the savings of those who endeavor to provide security for their dependents and for their old age. These must have proper stimulative return as a reward for their enterprise and their self-denial. There is the trusteeship for a vast body of employees that they should have stability in employment and a sense of security for work conscientiously performed, that they should have a growing standard of living and comfort, and full opportunities for recreation and education. There is an equal trusteeship to the whole public who are served by the products of these enterprises. It is in the public interest that the product should be multiplied; should be given with every advantage of technical excellence and service and upon the best terms which can be attained with due regard to the two other strong obligations toward which our leaders must also look. This trusteeship goes even further. Constant gains to each group depend upon the elimination of waste and the constant development of science and invention, of increasingly more efficient organization. Beyond this again these organizations must be held high in the business and ethical relations by the character of their leaders. They must be conducted in a fine sense of non-interference with human rights.

"I know of no responsibility larger than that imposed upon the headship of great industries, for from their leadership and their vision must come not only great contributions to our economic progress, but upon it depend the solution of the many social problems which confront us. We have a real and growing measure of this sense throughout American industry. And Mr. Young has been the expression of this type of leadership.

"There is one final thought to which I should like to give expression. Our friend and his colleagues in entering upon this mission to Europe, and in contributing so much to its high accomplishment, occupied the unique position of private citizens. Mr. Young is honored tonight as a private citizen. Does this not illuminate the potency and possibilities of private citizenship in a real democracy? Here is a world service of sublime accomplishment rendered by individuals bearing none of the trappings of public office, but who, nevertheless, were accepted as the representatives of the intelligence and instinct, good will and faith of the American people—and represented it to the pride of their countrymen."

Thyssen Impressed by Our Steel Mills

Fritz Thyssen, the greatest figure of industrial Germany, recently gave his first interview on his impressions of the American steel industry after five weeks' inspection in Pittsburgh and Chicago, according to the *New York World*.

His visit, coinciding with reports of an agreement between German and French steel interests, gave rise to rumors that America is to be asked to participate in a Central European combine. This and other questions of the industrial and political future of Europe he dismissed abruptly. His statement, which was written in a small hand on hotel stationery, follows:

"Since many years most courteous relations have been entertained by the American and German steel industry, strengthened by frequent personal intercourses and by the visiting of plants on both sides. We are glad to have had the opportunity of renewing this pleasant practice by visiting a good number of the leading steel works of your great country.

"We have much pleasure in expressing our most sincere thanks for the very kind and generous reception extended to us by all those on whom we were happy to call and specially by the officers of the United States Steel Corp. We are thankful, too, for the friendly efforts shown in order to make our visit a pleasant and useful one.

"We are deeply impressed by the most wonderful technical installations of the exceedingly powerful plants seen, by their remarkable organization and energetic and successful management."

Ernest Still Heads Patents Committee

In the rearrangement of committee assignments in the Senate no change was made in the chairmanship of the Patents Committee. Senator Ernest of Kentucky will continue in that chairmanship. He had been considered for other assignments that would have necessitated the surrender of the Patents chairmanship. These plans, however, did not materialize. This is of particular importance, since Senator Ernest is known to be in full sympathy with the plans of the Interdepartmental Patents Board to secure prompt consideration of its legislative program dealing with the handling of Government patents.

The new Senators from Massachusetts and Rhode Island, Messrs. Butler and Metcalf have been designated to fill the vacancies on the Patents committee.

Vonnegut Inaugurates Tool Exhibit

An exceptionally novel and enterprising exhibition of machine tools, power transmission and small tools was staged this week by the Vonnegut Machinery Co., Indianapolis, Ind., and was attended by engineers and industrialists from all parts of Indiana and adjacent states. Many of the motor driven machines were in full operation during the show and demonstrators were on hand to show the visitors the various machines that were on display.

The motto of this company—"Machinery Is an Investment, Not an Expense,"—was amply proved by the reception given to the people who attended the show. Several new attachments and some changes were shown in the new tools while standard lines were featured.

Decline of German Machine Exports

German machinery exports have fallen off considerably since the stabilization of German currency, according to report to the Department of Commerce from Vice-Consul Magnuson, Stuttgart.

It is generally known that German machinery exports have slumped badly during the past two years, but instead of recuperating since the passing of the paper mark, as was hoped, the stabilization of German currency has had a distinctly reversed effect. Exports of machinery from Germany have not only not improved in 1924, but show decided slumps during the first half of the year. Monthly averages of exports of industrial machinery in 1923 declined approximately 33 per cent below those of 1922. Corresponding figures for 1924 show a decline of about 15 per cent under those of 1923. The largest decreases during the current year occurred in exports of milling machinery which declined 38 per cent; lifting machinery, 32 per cent: shoe and leather machinery, 32 per cent; and woodworking machinery, 31 per cent.

Czechoslovakia Controls Own Industries Assert Czech Machine Tool Agents

Statement applied to markets for machine tools

By M. Kocian and G. Nedela
Agents in Prague for Several American Machine and Tool Manufacturers

We feel compelled to differ with some of the statements of W. H. Rastall that appeared in his address before the National Machine Tool Builders' Association, published in the *American Machinist*, Vol. 61, No. 16, page 636b. Mr. Rastall says, "For example, in Czechoslovakia the statement is very frequently made that the market should be approached only through a Czechoslovak. Obviously, to the extent that industry in Czechoslovakia is still in the hands of German interests it will be necessary to approach these industries through German rather than Czech sales channels."

Permit us to point out that of the large industries those making the following products are entirely in Czech hands as concerns both management and financial interests: Automobiles and airplanes, electrical machinery and supplies, locomotives and steam engines, agricultural machinery, sugar-mill machinery, large and small arms and ammunition, machinery for breweries. The railroad shops are controlled by the government.

Each of these industries employs at least 10,000 people when working at full capacity. The Skoda Works, for example, employs 15,000. There are no industries of equal importance to machine tool builders in German hands and under German financial control.

German Control Limited

True, there are large industries partly in Czech and partly in German control, but they are not so important as markets for machine tools as the others mentioned. They are: Glass works, textile shops, coal and iron mines, steel and pig iron works, shoe factories, woodworking factories, and sugar- and alcohol-producing plants. The largest shoe factory, T. & A. Bata, employing 13,000 people, is in Czech hands, and the same is true of almost all of the woodworking factories.

A statement was made by Mr. Rastall that he found bitter national feeling in Czechoslovakia. It can be found among people who make their living out of nationalism, but we do not find it among the German common people and the German manufacturers. Rather are they glad to be in Czechoslovakia, for two reasons: They profit by the high degree of social and industrial consolidation that Czechoslovakia has attained since the armistice. They have in Czechoslovakia all the advantages of a victorious nation in that they are not obliged to carry the heavy financial burdens existing in Germany.

There appears to be some inconsistency in statements made in the address to the effect that on the one hand Czechoslovakia is actively buying and will continue to buy American machine tool equipment on account of the degree of reconstruction now attained, and that on the other hand industry is in German hands. Does it seem reasonable that if Czechoslovakia did not control her own industries she could make remarkable progress in reconstruction? In this connection bear in mind that of the 14,000,000 inhabitants 10,000,000 are Czechoslovaks, 3,000,000 Germans and 1,000,000 Poles, Russians, Jews and Magyars.

There is another reason why Czechoslovakia buys American machines. It is because her people see in America our great liberator. As far back as 1919 or 1920 we felt the sympathy of the Czechoslovakian people for the Americans and wrote to some of our American friends that Czecnoslovakia would be the first country in Central Europe to import American machine tools in considerable volume. That prophecy is now being fulfilled.

Czechoslovak Attaché Comments Upon Address

The following letter has been received from Ales Broz, Attaché, on the stationery of the Czechoslovak Consulate General of 31 E. 17th St., New York City:

"I should like to draw your attention to a statement made by W. H. Rastall and published in your issue of Oct. 16 in which Mr. Rastall suggests that, in view of the fact that the machine tool industry in Czechoslovakia is still in the hands of German interests, it is 'necessary to approach these industries through German rather than Czech sales channels.' In this connection I should like to respectfully point out that about three-fourths of the Czechoslovak tool industry is in Czech hands and, therefore, I do not agree with Mr. Rastall in suggesting German rather than Czech channels."

Labor Legislation Association Meeting

The eighteenth annual meeting of the American Association for Labor Legislation will be held at the Congress Hotel, Chicago, Dec. 28, 29, and 30, with a program that promises to be filled with interesting and instructive discussions on questions of vital importance to manufacturers in all lines of endeavor. This association differs from others in that it has for its officers and promoters persons of national and international reputation who have for their aim better social conditions rather than the narrower personal interest that, according to members of this society, characterize many of the industrial organizations. Jane Addams, John R. Commons, Robert W. De Forest, Irving Fisher, V. Everit Macy, Henry R. Seager, Lillian D. Wald, Felix M. Warburg and Stephen S. Wise are the vice-presidents of the association while Thomas L. Chadbourne is the president. Adolph Lewisohn is the treasurer.

Many eminent speakers will be heard at the meeting this year. James A. Field, of the University of Chicago; Jane Addams, Hull House, Chicago; William Draper Lewis, director of the American Law Institute; Ernest G. Draper, treasurer of the Hill Bros Co., New York; Thomas I. Parkinson of Columbia University; Robert Bruere of the *Survey;* Joseph Schaffner of Hart, Schaffner & Marx, Chicago; Stuart Rice of Dartmouth College; and many others are scheduled and will either preside, present papers or enter discussions.

Designs Building for Industrial Museum

A suitable building to house the exhibits of the National Museum of Engineering and Industry has been designed by Frederick A. Waldron of the American Society of Mechanical Engineers in co-operation with the Smithsonian Institute and the Fine Arts Commission which is charged by Congress with the beautification of the National Capitol. The building site is the Mall, near the present Smithsonian Institute and is to be 1,150 ft. long by 200 ft. wide with classic facades. There will also be branch museums in the leading industrial centers.

Probable Production of General Electric

The General Electric Co. is expected to produce around $65,000,000 new orders for the final quarter of this year compared with actual bookings of $58,389,832 received in the quarter ended Sept. 30 and with $74,452,442 in the corresponding period of 1923.

Such a result would bring the year's total orders to substantially over $268,000,000, a decrease of about 12 per cent from the $304,199,746 received in 1923.

While current business has failed to attain the volume of a year ago, a satisfactory upturn in the past two months accounts for the improvement made thus far over the previous quarter. The improvement has been reflected largely in departments manufacturing small motors and light electrical equipment, turbine and generator departments having failed to respond to improving business trend.

It is estimated that the General Electric Co. is operating at slightly under 70 per cent, the increase in incoming orders having been too recent to influence the trend of production.

November Auto Output Shows Decrease

The motor vehicle production in November, according to preliminary estimates by the National Automobile Chamber of Commerce, was 248,113 cars and trucks compared with 289,343 in October and 313,012 in November, 1923.

The Business Barometer

This week's outlet in Commerce, Finance, Agriculture and Industry based on current developments

By Theodore H. Price
Editor, *Commerce and Finance, New York*

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AS THE end of the year approaches the business community is becoming interrogatory rather than affirmative in its attitude toward the predictions of prosperity now current.

The stock market has been somewhat quieter. Interest rates are a little higher especially in the West. The banks are protesting bitterly against the action of the Federal Reserve institutions in buying "eligible acceptances" at less than 3 per cent. Call loans have been as high as 4 per cent in New York and, while the very best commercial paper can still be sold at 3¾ per cent, it is doubtful whether the average borrower can do better than 4 per cent.

Gold has commenced to move out in quantity. During the week ending Dec. 6 the shipments were $12,000,000 and, although the exports for last week are not yet published, it is expected that they will be large.

Sterling exchange has continued to advance meanwhile. It sold at 4.71 on Tuesday and some London bankers prophesy that it will be back at par by spring. Foreign exchange on Holland, Sweden and Switzerland is also strong and there is every indication that the large foreign balances held here are being gradually withdrawn.

All this is perfectly normal but with a return to normal people are becoming a little more deliberate in studying conditions and attention is being drawn to some facts that are not altogether in harmony with the undiscriminating optimism recently prevailing in some quarters.

Thus the Secretary of the Rhode Island Textile Association has issued a formal denial of the report that 116 Fall River cotton mills would resume work on Dec. 8. He says that only five or six Fall River mills started full time operation on the date named and that the great majority will continue to run on part time schedules until conditions in the goods market improve.

Another item that is at variance with most newspaper headlines, is R. G. Dun's report that the building permits issued throughout the country in November call for an expenditure that is 16 per cent below the same month last year. But in the interest of accuracy it should be noted that Bradstreet's reports only 8.8 per cent decrease in the November building permits granted at 162 cities and that the F. W. Dodge Corporation reports an increase of 19 per cent over last year in the contracts let for construction during November in 36 Eastern States which include "about seven-eights of the total construction of the country."

The discrepancy between these three reports shows how hard it is to get facts. Perhaps the postal receipts at 100 larger cities may be a better guide. As compared with last year they show an average decrease of 1 per cent. At New York in particular, the falling off is 2.08 per cent. Then there is the reduction in the price of automobiles that a few manufacturers have announced and the smaller attendance that some people think they notice at the moving picture shows.

But these are only straws to which attention is drawn from a sense of duty. They may or may not indicate a change in the current and it is to be admitted that bank clearings and car loadings reflect an increase in the volume of the business passing and that the demand for steel and copper continues to gain.

Hides and leather are a shade firmer as a shortage of cattle next spring is confidently predicted. The high cost of corn and other feed is leading most of those who own cattle and hogs to sell them now rather than to fatten them and an advance in the price of meat next year seems almost inevitable.

Retailers say that their business does not yet indicate that people are spending more than last year. A good Christmas trade is developing, but it runs to necessaries rather than to luxuries and it is significant that the demand for diamonds is so poor that some of the South African mines are shutting down.

At a convention of the American Petroleum Institute at Fort Worth several speakers predicted the early exhaustion of America's oil supply, but they also admitted an over production at present and their remarks have been without effect on the market.

Although 14,398 bills have been introduced in the present Congress its deliberations have attracted but little attention. One of the bills offered is designed to facilitate or compel the early consolidation of the railroads. Although it has quickened the hopes of those who are long of railroad stocks it seems unlikely to pass and the various combinations planned are still subject to review by the I. C. C. As people weary over the delay that is inevitable a quieter stock market is likely and by the end of the year the facts plus the reasonable probabilities may displace sentiment as a price making factor.

The weekly statement of the Federal Reserve Banks shows a decrease of $30,000,000 in the gold held. The other changes are not significant and the reserve ratio is 75.2 per cent compared with 75.1 a week ago.

Politically as well as commercially the world seems to be getting back to pre-war conditions. The important question is will it get back to pre-war prices when its supply of gold is redistributed?

What's Doing in Industry

Reports from the middle west state that a definite improvement has already set in in the machinery and machine tool business and that the future is brighter than at any time in two years. Eastern machinery men are still optimistic as to the future, but state that buying has not been noticeably active during the past week.

One source of potential orders will be Canada. Our northern neighbor is gaining in prosperity, according to the latest Dominion reports.

Further reports show that not only is the United States Steel Corp. busy but that all steel mills are receiving orders enough to insure steady work for some time to come.

Automobile builders and accessory makers are both planning expansions after the first of the year and some of the Michigan manufacturers have already placed good sized orders, subject to further confirmation, with machine tool builders in New England and Ohio.

The small tool market reports better business during the past few weeks and prospects for future improvement.

The Industrial Review

Progress of the machinery and machine-tool business in various parts of the country

THE following reports gathered from the various machinery and machine tool centers of the country, indicate the trend of business in these industries and what may be expected from the future:

New York

Railroads were the chief buyers in a dull market in the New York district last week and machinery and machine tool men state that they must be content for two weeks of lethargy until the holidays have passed. Both the New York Central and the Lehigh Valley railroads bought tools, the first buying six medium-priced machines and the latter buying eight, some of which were expensive heavy machinery. Another purchaser in the New York market was the General Railway Signal Co. of Rochester.

Dealers report that automobile makers in New England and in New Jersey are both about to enter the machine tool market and that the New England factory is getting ready for materially increased production after the first of the year. Accessory dealers in the East are buying regularly, but their purchases are mostly of the small tool variety.

Used tool dealers report a slump which has lasted for several weeks. While there are many bargains to be picked up by these dealers, they are loath to invest when their market remains so uncertain.

Milwaukee

The progress of the metalworking machinery market meets fewer and less important impediments, and while the situation is still inclined to be spotty, major opinion agrees on the point that improvement of a definite character has come. Sales by dealers during the first half of December have been of a nature confirming hopes expressed as November came to an end that the new month would record a substantial increase in volume of business, and so far as can be ascertained, this month is holding its own with the corresponding period in 1923.

As in other principal production centers and distribution markets, the purchases made by the Nash interests of Kenosha, Wis., principally in behalf of the Ajax Motors Co. of Racine, Wis., have injected a bright spot into the tool situation locally. Some of this business has been placed with makers in Milwaukee, Madison, Beloit and Racine. New England is getting a substantial share, and Cincinnati is benefiting as well. The Nash-Ajax list, while it has not been issued as such in its entirety, represents one of the heaviest purchases of metal working equipment in probably a number of years, and one that will require several months longer to complete.

Railroad business is gradually coming out of a purely prospective state. The Chicago, Milwaukee & St. Paul, that maintains one of the largest locomotive and car shops of its system in Milwaukee, is expected soon to be in the market for the initial items of a list of more than ordinary size to bring this shop to full efficiency. Practically no replacements or additions have been made for several years, due to the necessity of strict economy, but President H. E. Byram has made personal inspections on a number of occasions recently and indicated that steps will be taken to modernize the equipment throughout. The work probably will be spread out over a considerable period of time.

Local makers and dealers are not figuring on any sharp increase in demand after Jan. 1, yet they expect to see the best buying in the January-April period that they have experienced in a number of years. The increase in inquiry, that is steadily growing, supports this view.

Buffalo

A more satisfactory outlook is indicated by the general tone of the Buffalo machinery market at this time, even though there is not, by any means, a rush of business. If optimism on the part of the trade can have anything to do with the situation, a general betterment of conditions can be looked for in the near future. In fact, the concensus of opinion seems to be that there will be material progress made right after the first of the year.

Immediately following election, the local machinery trade experienced a little spurt of business, but after that it fell back into the lethargy that had characterized business for some time. Most of the firms reporting say they did a fair business in November, considering the time of the year, and that business is a little better right now but that neither month will compare favorably with October. The reason seems to be that the larger industries of this territory are holding off now until after inventory time before making any announcement of their future plans.

However, many executives at the head of large plants tell machinery salesmen that they have in mind very material increases in plant equipment early in 1925 but that right now they are marking time until they can note accurately the reaction of the country and of business as a whole to the results of the recent election.

One matter of substantial encouragement is the fact that from all parts of the territory come reports that business is looking a little better all the time. This spirit of optimism and of actual progress is bound to be reflected soon in real buying of machinery. Several of Buffalo's plants in the automotive field and other lines that have been closed down or partly closed down are operating on a more extensive scale now and probably will be going very well indeed after the first of the year. The steel mills are working more extensively than they have in months.

One large list is reported out at the present time. This list was prepared by a Buffalo industrial and includes radial drills, heavy duty lathes, boring mills and quite an amount of small stuff. Several local machinery dealers have been asked to make bids on all or a portion of this equipment and it is estimated that the total amount may run between $40,000 and $60,000. It was expected that some orders on this list would have been placed before this, but as yet nothing has developed.

The Buffalo Forge Co. reports that its business is holding up very well on a comparative basis. There was quite a spurt immediately after election, but there has not been quite the same spontaniety to the market since. However, several big things are in the offing for this company and its executives feel very confident of business during the first of the new year.

One encouraging sign is that the railroads are issuing lists for the first time in some months. The New York Central, for instance, has a list out calling for a number of portable electric drills. Other railroads in the vicinity are preparing lists.

Canada

The machinery and machine tool business of Canada is quiet just now, but the general consensus of opinion is that it will not continue that way for long. There is every indication that the turn of the year will see a big improvement. Release of substantial orders, and inquiry for considerable tonnages, indicate that the next two months will provide the steel mills of eastern Canada with better business than they have had for some time. Things are not going so well, however, with the steel industries down in the Maritime provinces. A large deputation from Nova Scotia waited on the federal government a few days ago with the object of seeking immediate assistance for those industries. The government was asked to use its good offices with the Canadian National Railways for the securing of substantial orders for steel rails and fastenings to be manufactured during the winter months. The deputation also asked for a readjustment of certain items in the tariff as it affects the production of primary articles of steel.

In Toronto iron and steel warehouse business has been large, with steel bars leading in popularity. Old material is on the upward move. Structural steel jobs recently released throughout the

province of Quebec and the Maritimes, provide tonnage which will give fabricating shops considerable work.

There is very little railway buying at present. The railways are buying on a hand to mouth basis, but there is little doubt that they will, in the not distant future, come into the market for much rolling stock. In announcing a $30,000,000 bond issue a few days ago, the president of the Canadian Pacific Railway stated that works in contemplation to provide for the railway's traffic and for the betterment of existing facilities will require a considerable sum.

The Ontario Wind Engine & Pump Co., Ltd., of Toronto reports sufficient orders in sight to keep a full force running all winter. Building and engineering contracts awarded in the Dominion during November exceeded those of October by $3,500,000.

There is at present a very marked tendency on the part of United States business and industrial firms to take a greater interest in Canada both as a market and as a source of raw materials. Canada's market in the United States, moreover, is gradually expanding despite tariff barriers. During the year ending with October, 1924, the Dominion sold to the United States $428,271,877 worth of goods as against $422,383,373 for the previous year.

Detroit

The last two weeks of 1924 will witness a decrease in the machinery and machine tool industry in Detroit and its environs because of the annual inventories being taken by a large number of automobile and accessory plants in Michigan.

Leaders in the machine tool field are not anticipating anything but a few orders during the next two weeks, but evidences of a resumption of full production in the automotive field after Jan. 1 has led to the general belief that next year will be one of the best machinery dealers have experienced in a long time.

Behind the curtains in the automotive game preparations are being made for the big national automobile shows to be held in January in New York, Detroit and Chicago. Important announcements are scheduled for the shows, and many of these will have a vital effect upon the machine tool field here.

Some of the larger handlers of machinery and machine tools report that many plants are stocking up with more die room and tool room equipment than for some time. A very large proportion of recent sales has been for this class of tools.

New England

There has been a fair amount of buying in the small tool trade during the past week and a good improvement in the hand tool trade. In much of this buying, however, the requirement of 60-day datings was noticed. Comments of sales directors were to the effect that deferred dating appeared to be more widely insisted upon than a year ago.

Production superintendents are now engaged in making up their schedules for next year and in the majority of cases experience of the current year is taken as a basis and to this is added a percentage figured out on prospective business indicated in the inquiry mail. Conditions are optimistically regarded for 1925 in New England.

The buying of heavy machinery has slowed down to what it was during the first week of November and, although this condition prevails, the prospective business has gained. The inquiry mail from the automotive industry is of increased volume. The parts-makers of the East also say that business is improving. It is expected that contracts already figured on will shortly be settled definitely. Several of considerable volume are in prospect. In regard to one referred to two weeks ago the manufacturer said that, while the delivery is delayed its prospects are favorable and will result in a great boom for that particular locality.

Business is now of the year-end variety. Operations continue along the usual schedules and no immediate changes are expected.

Chicago

It is reported in Chicago that the Illinois Central, the Chicago Burlington & Quincy, the Chicago, Milwaukee & St. Paul and the Chicago & Northwestern railroads have outlined a machinery program that will call for the expenditure of between $250,000 and $300,000. This report has had a stimulating effect in the machinery market, although the requirements of the roads have not yet been definitely announced. The recent orders placed by the Nash Motors Co., of Racine, Wis., and by its subsidiary, the Ajax Motors Co., include 29 automatic lathes, to cost $100,000; gear cutters costing $25,000, two centerless grinders, and other milling machinery calling for a considerable outlay, with standing equipment still to be ordered.

At Rockford, Ill., the National Lock Co. reports purchases of two vertical milling machines, two hand milling machines and nine spindles of sensitive drills. The Johnson Service Co., of Milwaukee, reports the purchase of 30 spindles of sensitive drilling machines. Taken by and large, the tone of the Chicago machinery market is encouraging, but, as has been said previously, no material activity in the movement of machine tools is looked for until after the beginning of the new year. Inquiries are normal for the season and compare favorably with those received at this time a year ago.

Patent Office Makes Annual Report

Total receipts of the Patent Office amounted to $3,042,276 for the past fiscal year, the largest ever received for any single year, according to the annual report submitted to the Secretary of the Interior. This increase was made notwithstanding a slight decrease in the number of applications for patents, designs, and trade marks from 100,724 for the preceding year, to 99,503 for the last fiscal year.

The great activity in the Patent Office was shown by the reduction in the amount of work awaiting official action, the report pointed out.

Personals

CHARLES PIEZ, of the Link-Belt Co., succeeded E. C. Heidrich, Jr., as president of the Illinois Manufacturers' Association at the election held on Tuesday, Dec. 9. Other new officers elected were: F. L. Mansure, first vice-president, and L. H. Armour, of Armour & Co. second vice-president. Peter S. Theurer, and John M. Glenn, were re-elected treasurer and secretary, respectively.

EDWARD FLOWERS has been appointed sales agent in the Huntington, W. Va., territory for the American Engineering Co., Philadelphia.

F. E. BARDROF, formerly associate editor of the *American Machinist*, has joined the organization of the Cleveland Worm & Gear Co., Cleveland, Ohio.

J. F. KROSKE has been appointed manager of the pneumatic tool sales for the Ingersoll-Rand Co., New York, in its Pittsburgh district.

JOHN GERMONPREZ has been appointed factory manager of the Paige-Detroit Motor Car Co., Detroit, to succeed George Petersen who was recently elected a vice-president.

RAYMOND H. SULLIVAN, vice-president in charge of manufacturing at the North & Judd Manufacturing Co., New Britain, Conn., has for the time being assumed the duties of works manager in addition to his other duties.

GUY HUBBARD, who for nine years has been connected with the engineering department of the National Acme Co., Windsor, Vt., has resigned and will become assistant to Henri A. Sevigne, manager of the National Bread Wrapping Machine Co., Nashua, N. H.

D. W. STORK of Stork Bros., Hengelo, Holland, has left New York for a trip to the Pacific Coast, visiting the important industrial centers. His address while in this country is in care of R. S. Stokvis & Sons, 17 Battery Place, New York. Stork Bros. are makers of uniflow engines, turbines, sugar mill machinery and hoisting equipment.

FORREST T. ELLIS, formerly superintendent of tools and equipment, has been named superintendent of manufacturing of the Cadillac Motor Car Co., Detroit.

THOMAS M. REECE, formerly with the Treadwell Engineering Co., Easton, Pa., and also the Pittsburgh office of the Motch & Merryweather Machinery Co., has joined the organization of Manning, Maxwell & Moore in the Pittsburgh district.

A. H. KRIGGER has taken over the sales of the Crescent industrial truck manufactured by the Crescent Truck Co., Lebanon, Pa., in the Pittsburgh district. His headquarters are at 404 House Building.

M. H. O'HAYER has been appointed assistant to the sales manager of the North & Judd Manufacturing Co., New Britain, Conn.

CLIFTON REEVES, industrial engineer, announces the removal of his offices from 149 Broadway to the Westinghouse Building, 150 Broadway, New York City.

ALFRED HERBERT, Ltd., Coventry, England, is now sole selling agent in Great Britain and Ireland for the Norton grinding wheels.

R. U. LIPSCOMB has been appointed superintendent of motive power of the Southern Pacific Railway, with headquarters at El Paso, Texas. Mr. Lipscomb was formerly chief assistant superintendent of motive power and equipment of the Texas and Louisiana lines of the same company.

WALTER G. HELBER, identified during the last 17 years with the Buick Motor Car. Co. of Flint, and recently master mechanic of the motor plant, has joined the Ajax Motors Co. of Racine, Wis., in the capacity of general superintendent.

GEORGE PETERSEN has been elected vice-president of the Paige-Detroit Motor Car Co., Detroit, in charge of the manufacturing division. Mr. Petersen has held the position of factory manager for some time.

Business Items

The Cleveland Worm & Gear Co. is now located in its new plant, 3249 to 3299 E. 80th St., Cleveland.

The Cleveland office of the Sullivan Machinery Co., Chicago, is now at Room 701 Rockefeller Building instead of at 824 Rockefeller Building.

The Cadillac Machinery Co. Detroit, Mich., has been appointed agent for the state of Michigan for Baker Bros. multiple-spindle cylinder-boring machine. The Motch & Merryweather Machinery Co. will continue to handle Baker Bros. regular lines in eastern Michigan and the Marshall & Huschart Machinery Co., Chicago, in western Michigan.

The Golden State Machine Works has been started at 1038 Twenty-Third Ave., Oakland, Calif. J. O. Hamren is manager, Johann Hain is superintendent, and B. Johnson is foreman.

The Manitoba Bridge & Iron Works, Ltd., and the Manitoba Steel & Iron Co., have practically completed arrangements for an amalgamation, the change to take effect the first of the new year. Under the new scheme the warehousing business of the steel and iron company will be carried on by the bridge concern, which is the parent company.

The Superior Bolt & Screw Co., Ltd., has been granted a federal charter in Canada. The new company is capitalized at $350,000, and headquarters are in Montreal.

Obituaries

MEL BARNES, president of the Barnes Scale Co. of Detroit, died at his home here recently.

Pamphlets Received

First Report of the Committee on Education of Associated Industries of New York State. Published by Associated Industries, 701-704 Iroquois Building, Buffalo, N. Y. This is the first of the educational series to be published by this association in which the subjects of trade and technical education, apprenticeship training and plant training, immigration education, foreman training, industrial rehabilitation and accident prevention and health education are discussed. There is also contained in the booklet some interesting and important facts regarding manufacturing industries in New York State.

Pickling of Iron and Steel. Compiled by Victor S. Polansky. Published by the Carnegie Library, Pittsburgh, Pa. This booklet is a bibliography in which briefs of various articles and recent patents both in the United States and abroad are tabulated. It is classified by authors and the subjects covered are: Machines and equipment; Pickling in Acid Solutions; pickling in salt solutions; Electrolytic pickling; inhibitors and accelerators; effect of pickling; and recovery of spent liquors.

Trade Catalogs

Electric Hoists. The Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The catalog recently issued by the Shepard company illustrates and describes the floor operated hoists that the company makes. The various types and forms are briefly portrayed with excellent illustrations showing the hoist in operation and a "close-up" view of the product itself. Data, price lists and dimension tables are included in the catalog.

Ball Bearings. The New Departure Manufacturing Co., Bristol, Conn. Six new data sheets for the New Departure Engineering Bulletin Service have been mailed out by this company. They are to take the place of other sheets previously sent to the trade and cover subjects of mounting and handling ball bearings, capacities of ball bearings at various speeds, and other pertinent information.

Trucks. The R. G. Haskins Co., 516-520 W. Monroe St., Chicago, Ill. Metal-wood panels, armored trucks, mill boxes and bench tops are described in the catalog with suitable illustrations showing the products and their advantages. Dimensions of the trucks, boxes and bins are given.

Welding and Cutting Apparatus. The Burdett Manufacturing Co., Chicago, Ill. Oxy-acetylene and oxy-hydrogen welding and cutting apparatus are described and illustrated in the catalog. Torches, mixers, tips, regulators and other accessories are shown. The many uses of the products are also tabulated.

Gear Drive. The Mesta Machine Co., Pittsburgh, Pa. Bulletin B shows the double helical cut tooth gear drive made by this company in the making and in place at various foundries and steel mills in the United States and Canada. The bulletin is well arranged and the story is easily told by good illustrations and concise descriptions.

Woodworking Machines. J. D. Wallace & Co., Chicago, Ill. The various planers, jointers, circular saws, lathes, and attachments for woodworking machinery are described in this catalog. There are many illustrations showing successful installation and usage.

Automatic Cylindrical Grinder. The Arter Grinding Machine Co., 72 Commercial St., Worcester, Mass. A folder describing the product of this company and illustrating the various parts of the machine has been mailed out. Other machine tools made by this company are: rotary surface grinder, automatic ring grinder, semi-automatic ring grinder, cylindrical lapping-grinder, flat lapping-grinder, and magnetic chuck.

Centrifugal Pumps. The Earle Gear & Machine Co., Wayne Junction, Philadelphia, Pa. Single-stage, double-suction centrifugal pumps made by this company with motor drive, belt drive, turbine drive, and steam engine drive are illustrated and described in this latest catalog of the Earle company. Charts, lists and a chapter called "Useful Information," make up the booklet.

Polyphase Motors. The Century Electric Co., St. Louis, Mo. A folder of four pages describing the bearing and oil well construction of the Century polyphase motors has been sent to the trade. Illustrations show sections of the housing and well.

Arc Welding Generators. The Allan Manufacturing & Welding Co., Buffalo, N. Y. Leaflets have been mailed out by this company showing various types of generators and transformer arc welders. Short descriptions tell the story of the products.

Production Tools. Goddard & Goddard Co., Detroit, Mich. Milling cutters of various size are described in two pamphlets, Nos. 3 and 4, recently issued by this company. The work that the products will do, as well as short descriptions of other tools, are included in the booklets.

Industrial Paints. The Truscon Laboratories, Detroit, Mich. The Truscon maintenance map has been mailed out. It has a cross-section of a factory with keyed figures showing which paints, varnishes or enamels are best suited for that particular part of the building.

Drafting Machines. The Universal Drafting Machine Co., Cleveland, Ohio. A folder showing the methods employed in utilizing the drafting machines made by this company has been issued. Speed, ease of drawing and other advantages are emphasized.

Hobbing Machines. Gould & Eberhardt, Newark, N. J. The hobbing machines made by this company are shown by illustration in a new perforated booklet. There is a story telling the basic principles of design, the development of the machine and the features to be found also in the booklet.

Screw Thread Comparator. The Jones & Lamson Machine Co., Springfield, Vt. A four page folder describes the Hartness Screw Thread Comparator and a diagram on the last page shows the arrangement of parts and the method of operation.

Export Opportunities

The Bureau of Foreign and Domestic Commerce, Department of Commerce Washington, D. C., has inquiries for the agencies of machinery and machine tools. Any information desired regarding these opportunities can be secured from the above address by referring to the number following each item.

Air compressors. Montevideo, Uruguay. Purchase. Reference No. 12,552.

Sheet metal working machinery, machines for cutting, stamping, finishing and bending steel tires and for making aluminum household articles, capsules, boxes and tubes. St. Chamond, France. Purchase. Reference No. 12,555.

Wood and metal working machinery. Prague, Czechoslovakia. Agency. Reference No. 12,550.

Forthcoming Meetings

American Association for the Advancement of Science. Meeting at Washington, D. C., Dec. 29, Jan. 1, 2 and 3. Burton Livingston, Smithsonian Institute, Washington, D. C.

American Society for Steel Treating. Winter Sectional Meeting under the auspices of the Cincinnati chapter. Thursday and Friday, Jan. 15 and 16, in Cincinnati.

Society of Automotive Engineers. Annual Meeting. Detroit, Mich., Jan. 20, 21, 22 and 23. C. F. Clarkson, 29 W. 39th St., New York City.

The Society of Industrial Engineers. National Convention. Hotel Winton, Cleveland, Ohio, May 6, 7 and 8. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago, Ill.

American Society for Testing Materials. Twenty-eighth annual meeting. Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., June 22, 23, 24, 25 and 26. C. L. Warwick, secretary-treasurer, 1315 Spruce St., Philadelphia, Pa.

National Foreign Trade Council. Annual Convention. Seattle, Wash., June 24, 25 and 26. O. K. Davis, secretary, India House, Hanover Square, New York City.

The Weekly Price Guide

Rise and Fall of the Market

Iron and Steel—Pig-iron production and demand active; price of No. 2 f'dry firm at $20 per ton, Birmingham, or about $1 per ton above a week ago. Tank plates are up $2 per ton. Ship plates, sheets, tin plates and steel pipe also in good demand. Sheets up 10 to 25c. and plates, 5 to 10c. per 100 lb. at mills, compared with levels of Dec. 5. Bars are $2.10; shapes, $2@$2.10; and plates, $1.85@$2.10 per 100 lb. Pittsburgh.

Non-Ferrous Metals—Market stronger in all non-ferrous metals with the possible exception of Chinese antimony. In New York warehouses—copper up ¼c.; lead, ⅛c.; and zinc, ¼c. per lb. since Dec. 5. The copper market is extremely active with prices highest for the year; tin is unusually steady; lead, rising here and abroad; and zinc, higher because of decreased supply.

Linseed Oil—Up 3c. in New York and 5c. per gal. in Chicago during week.

(All prices as of Dec. 12)

IRON AND STEEL

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern	$23.05
Northern Basic	22.27
Southern Ohio No. 2	22.27
NEW YORK—Tidewater Delivery	
Southern No. 2 (silicon 2.25@2.75)	28.25
BIRMINGHAM	
No. 2 Foundry	20.00
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.75)	23.00
Virginia No. 2	29.75
Basic	21.75
Grey Forge	21.75
CHICAGO	
No. 2 Foundry local	20.50
No. 2 Foundry, Southern (silicon 2.25@2.75)	25.00
PITTSBURGH, including freight charge from Valley	
No. 2 Foundry	22.77
Basic	22.77
Bessemer	23.77

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb.:

Detroit	4.75
Cleveland	4.75@5.00
Cincinnati	5.00@7.50
New York	5.00@5.50
Chicago	5.25@5.75

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the mill base in large lots.

Blue Annealed	Pittsburgh Mill Base	New York	Cleveland	Chicago
No. 10	2.70	3.89	3.45	3.80
No. 12	2.80	3.94	3.50	3.85
No. 14	2.90	3.99	3.55	3.95
No. 16	3.10	4.09	3.65	4.15
Black				
Nos. 17 and 21	3.45	4.40	4.15	4.30
Nos. 22 and 24	3.50	4.45	4.20	4.35
Nos. 25 and 26	3.55	4.50	4.25	4.40
No. 28	3.60	4.60	4.35	4.50
Galvanized				
Nos. 10 and 11	3.75	4.60	....	4.50
Nos. 12 and 14	3.85	4.70	....	4.60
Nos. 16	4.00	....	....	....
Nos. 17 and 21	4.15	5.00	....	4.90
Nos. 22 and 24	4.30	5.15	3.00	5.05
No. 26	4.45	5.30	4.15	5.20
No. 28	4.75	5.60	5.45	5.50

WROUGHT PIPE (Welded)—Warehouse discounts are as follows:

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv.	Chicago Black	Chicago Galv.
1 to 3 in. steel butt welded	48%	34%	55½%	43½%	56%	43%
2½ to 6 in. steel lap welded	44%	30%	53½%	40½%	53%	40%

Malleable fittings: Classes B and C, banded, from New York stock sell at list plus 4%; class A, plus 23%. Cast iron, standard sizes, 36% off.

Size, Inches	List Price per Foot	Diameters Inches External	Diameters Inches Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	.28

SEAMLESS STEEL TUBING—Following base discounts are on 20 gauge or .035-in., round, cold-drawn tubing, ¼-in. to 1-in., O.D., weighing 0.17 lb. to 0.36 lb. per ft. Cutting charge per 100 cuts, $1.50 to $1.58:

O.D. Inches	List Price per ft.	Differential Discount	O.D. Inches	List Price per ft.	Differential Discount
¼	$0.09	50%	⅞	$0.16	35%
⅜	.11	45%	1	.18	31%
½	.14	40%			

NOTE—The discounts are to be lowered by the following differentials in the case of regular .10-.20 carbon: 25,000 ft. or over, 83; 15,000 to 25,000 ft., 82; 5,000 to 15,000 ft., 81; 1,000 to 5,000 ft., 80; less than 1,000 ft., 79.

MISCELLANEOUS—Warehouse prices in cents per pound in 100-lb. lots:

	New York	Cleveland	Chicago
Open hearth spring steel (base)	4.50	6.00	4.20
Spring steel (light) (base)	7.00	6.00	6.00
Coppered Bessemer rods (base)	6.85	8.00	7.20
Hoop steel	4.49	4.35	4.15
Cold rolled strip steel	7.00	8.25	7.85
Floor plates	5.55	4.60	5.50
Cold drawn shafting or screw	4.05	4.00	3.80
Cold drawn flats, squares	4.55	4.50	4.30
Structural shapes (base)	3.34	3.20	3.10
Soft steel bars (base)	3.24	3.10	3.00
Soft steel bar shapes (base)	3.24	3.11	3.00
Soft steel bands (base)	3.99	3.20	3.65
Tank plates (base)	3.34	3 42½	3.10
Bar iron (2.90@3.00 at mill)	3.24	3.21	3.00
Tool steel	11.00	....	....
Drill rod (from list)	60%	55%	50%

Electric welding wire, New York, 3/32, 8.25c.; ⅛, 7.75c.; 5/32 to ¼, 7.25c. per lb. Chicago, 3/32, 8.85c.; 5/32, 7¾c.; ⅛, 7.95c. per lb.

METALS

Current Prices in Cents Per Pound

Copper, electrolytic (up to carlots), New York			15.00
Tin, 5-ton lots, New York			55.62½
Lead (up to carlots), St. Louis	9.12½	New York	9.75
Zinc (up to carlots), St. Louis	7.25	New York	7.75

	New York	Cleveland	Chicago
Antimony (Chinese), ton spot	15.00	16.50	16.50
Copper sheets, base	21.62½	21.62½	21.62½
Copper wire, base	19.62½	20.00	17.62½
Copper bars, base	20.87½	21.87½	20.87½
Copper tubing, base	24.00	24.75	24.00
Brass sheets, base	18.37½	18.50	18.37½
Brass tubing, base	22.75	24.00	26.37½
Brass rods, base	16.37½	17.62½	16.37½
Brass wire, base	18.87½	19.50	18.87½

Shop Materials and Supplies

METALS—Continued

	New York	Cleveland	Chicago
Aluminium ingots, 98 to 99%, 1–15 ton lots	27.20	28.00	27.00
Zinc sheets (casks)	11.75	12.00	11.37
Solder (½ and ½), (case lots)	40@41	34.00	33.50
Babbitt metal (83% tin)	60.00	65.00	50.00
Babbitt metal (35% tin)	28.00	19.50	28.00
Nickel (ingots) f.o.b. refinery	29.00	.....	.....
Nickel (electrolytic) f.o.b. refinery	33.00	.....	.....
Nickel (F shot) f.o.b. refinery	30.00	.....	.....

SPECIAL NICKEL AND ALLOYS—Price in cents per lb. f.o.b. Huntington, W. Va.:

Rolled nickel sheet (base)	52.00
Hot rolled rods, Grade "A" (base)	50.00
Cold drawn rods, Grade "A" (base)	58.00
Manganese nickel hot rolled rods "E"—low manganese (base)	54.00
Manganese nickel hot rolled rods "D"—high manganese (base)	57.00

Base price of monel metal in cents per lb., f.o.b. Huntington, W. Va.:

Shot	32.00	Hot rolled rods (base)	40.00
Blocks	32.00	Cold drawn rods (base)	48.00
Ingots	38.00	Hot rolled sheets (base)	42.00

OLD METALS—Dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
Crucible heavy copper	11.50@11.75	11 25	12.00
Copper, heavy, and wire	11.25@11.50	11 00	11.50
Copper, light, and bottoms	10.00@10.25	9.75	10.25
Heavy lead	7.00@7.25	6.75	8.00
Tea lead	6.00@6.25	5.25	6.75
Brass, heavy, yellow	7.25@7.50	7.00	8.00
Brass, heavy, red	9.00@9.25	9.25	9.50
Brass, light	6.25@6.50	6.00	6.75
No. 1 yellow rod turnings	7.75@8.00	7.00	8.00
Zinc	4.00@4.25	3.75	4.50

TIN PLATES—American Charcoal—Bright—Per box.

		New York	Cleveland	Chicago
"AAA" Grade: IC,	20x28, 112 sheets	$23.50	$22.85	$21.00
"A" Grade: IC,	20x28, 112 sheets	19.00	18.80	17.00
	Coke Plates—Primes, 20x28 in.			
100-lb.,	112 sheets	13.00	13.00	13.00
	Terne Plates—Small lots, 8-lb. Coating			
IC,	14x20	7.25	6.80@6.90	6.75

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.	$0.14@0.21	$0.19	$0.14@0.18
Cotton waste, colored, per lb.	.09@.14½	.18	.09½@.12¾
Wiping cloths, 13½x13½, per lb	.11@.11½*	36.00 per M	.11
Wiping cloths, 13½x20½, per lb.	.....	50.00 per M	.11
Sal soda, per 100 lb. keg	2.25	2.25	2.00
Roll sulphur, per 100 lb. keg	3.60	3.25	2.85
Linseed oil, per gal., 5 bbl. lots	1.14	1.15	1.10
Lard cutting oil, 25% lard, per gal.	.55	.50	.32
Machine lubricant, medium-bodied (50 gal. wooden bbl.), per gal.	.29	.35	.21
Belting—Present discounts from list in fair quantities (½ doz. rolls).			
Leather—List price, 24c. per lin. ft. per inch of width for single ply.			
Medium grade	40–2½%	30–10%	40–2½%
Heavy grade	30–5%	30%	38–5%
Rubber transmission, 6-in., 6 ply, $1.83 per lin. ft.			
First grade	50%	50–10%	60%
Second grade	50–10%	60–5%	65%

*White, at washery.

Comparative Warehouse Prices

New York	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars	per lb.	$0.0324	$0.0324	$0.0354
Cold finished shafting	per lb.	.0405	.0405	.044
Brass rods	per lb.	.1637½	.1537½	.155
Solder (½ and ½)	per lb.	.40@.41	.39@.40	.3375
Cotton waste	per lb.	.14@.21	.14@.21	11@14
Washers, cast iron (½ in.)	per 100 lb.	6.50	6.50	6.50
Emery, disks, cloth, No. 1, 6 in. dia.	per 100	3.38	3.38	3.38
Lard cutting oil	per gal.	.55	.55	.55
Machine oil	per gal.	.29	.29	.297
Belting, leather, medium	off list	40–2½%	40–2½%	30–10%
Machine bolts up to 1x30 in.	off list	45%	45%	45%

MISCELLANEOUS—Continued

	New York	Cleveland	Chicago
Abrasive materials—In sheets 9x11 in., No. 1 grade, per ream of 480 sheets:			
Flint paper	$4.86	$5.84	.....
Emery paper	10.71	11.00	$11.90
Emery cloth	28.00	31.12	32.75
Emery disks, 6 in. dia., No. 1 grade, per 100:			
Paper	1.49	1.24	1.65
Cloth	3.38	2.67	3.55
Fire clay, per 100 lb. bag	.....	.65	.75
Coke, prompt furnace, Connellsville	per net ton		3.50@3.65
Coke, prompt foundry, Connellsville	per net ton		4.00@4.50
White lead, dry or in oil	100 lb. kegs		New York, 15.25
Red lead, dry	100 lb. kegs		New York, 15.25
Red lead, in oil	100 lb. kegs		New York, 16.75

SHOP SUPPLIES

	New York	Cleveland	Chicago
Rivets: Button heads, ⅜-in., ¾-in., 1x2-in. to 5-in., per 100 lb.	$3.75	$3.50	$3.50
Cone heads, ditto	3.85	3.60	3.70
Washers, cast iron: ½-in. per 100 lb.	6.50*	4.00	3.75
⅝-in., per 100 lb.	5.50*	4.00	3.75

Machine bolts, up to 1x30-in., with cold punched and hot-pressed hex. nuts, also button head bolts with hex. nuts are $3.50 per 100 lb. at Cleveland. Tap bolts with hex. heads are $4.65 per 100 lb. at Chicago.

Machine bolts, ¼x1½-in., per 100, $1.70. Discount at New York warehouses on all sizes up to 1x30-in., 45%; 1½ and 1¼x3-in. up to 12-in., 15%; with cold punched hex. nuts up to 1-in. dia. (plus std. extra of 10%) 35%; with hot pressed hex. nuts up to 1x30-in. (plus std. extra of 10%) 40%.

Carriage bolts, ¼x1½-in., per 100, $1.00. Discount on all sizes up to 1x30-in., 35%.

Coach and lag screws, 1½x-$\frac{5}{16}$in., $2.25 per 100, less 45%.

Tap bolts, 1½x¼-in., $1.00 per 100. List plus 35%.

Bolt ends, 1x12-in., 10c. per lb., less 45%.

Nuts, semi-finished, ¼x¼-in., 2c. each. Discount 70% for $\frac{5}{16}$-in. and smaller and 65% for ⅜-in. and larger.
Case hardened, ¼x¼-in., 6c. each, less 50%.

Rivets, $\frac{7}{16}$x1-in. and longer, 19c. per lb., less 60%. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ⅜-in. dia., 35c.; ½-in. dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

*For immediate delivery from warehouse.

Machine Requirements and Industrial Construction

Machine Tools and Equipment Wanted

Ill., Chicago—Railway Materials Co., 400 North Michigan Blvd.—electric traveling crane for Stevens Point, Wis., branch.

Mass., Back Bay (Boston P. O.)—S. W. Flax, 59-75 Queensberry St.—general equipment and tools for repair and service garage.

Mass., Boston—Barrett Co., 11 Beacon St.—miscellaneous tools and equipment for repair and service garage, at Cambridge.

Mass., Braintree—Braintree Motors Co., Stedman St.—equipment for public garage and service station.

Mass., Cambridge — F. H. Davis, 175 Richdale Ave.—screw cutting engine lathe.

Mass., Jamaica Plain—P. J. Brady, 3722 Washington St. — miscellaneous tools and equipment for service garage.

Mass., Roxbury—M. Hatoff, 5-17 Cleaves St.—equipment for service garage.

N. Y., Buffalo — Bd. Educ., Telephone Bldg.—power operated machine for filing hand saws.

O., Portsmouth—The Monrad Eng. Co., 915 4th St.—A. L. Monrad, Pres.—one small demagnatizer (used).

Pa., Lathrobe — J. B. Moore — chucks, lathes, drills, motor driven equipment.

Pa., Phila.—Pennsylvania R.R. Co., S. Porcher, Gen. Purch. Agt.—one 10 ton pillar crane for Pittsburgh and one 10 ton hand traveling Gantry crane for Lebanon.

Tenn., Memphis — E. L. Bruce & Co., Thoma St.—one 24 in. x 24 in. x 6 ft. planer, one 20 or 24 in. x 12 ft. lathe, one No. 4 Universal milling machine, one 20 or 24 in. back geared sliding head drill press, (used modern tools in A1 condition).

Tex., El Paso—Hirsch Bros. Machinery Co., 1901 Bassett Ave. — automatic bar lathes for cutting steel bars, capacity 1¼ in. to 2 in.; automatic chucking lathes for the manufacture of cast iron flange shaft couplings and similar equipment; multiple drilling machine, also multiple drill heads suitable for use in a 6 ft. Baush radial drill; cutter and tool grinders for milling machine, cutters and reamers; boring mills; open side planer.

Wis., Kenosha—Hannah Mfg. Co., 528 Grand Ave.—woodworking machinery.

Wis., Kenosha — Nash Motors Co., Pomeroy St.—foundry equipment including moulding dippers, crane, etc.

Wis., Milwaukee—Maynard Electric Steel Castings Co., Kilbourn Rd.—special metal pattern working machinery.

Wis., Milwaukee — Peterson & Janssen, c/o H. Janssen, 1196 4th St.—die making machinery.

Wis., Monroe—E. Keel—lathe suitable for garage, drill press and air compressor.

Ont., Arden — J. E. Barker — complete equipment for saw mill and planing mill.

Ont., Formosa—A. M. Poechmann—miscellaneous tools and equipment for repair and service garage.

Ont., Galt—P. W. Gardener & Son, Harris St.—machine shop equipment for proposed shop, incl. lathe, drill and tools, electric power.

Ont., Holstein — Smith Bros. — general garage equipment and automobile repair tools.

Ont., Kincardine—A. P. Stewart—cut off saws, moulder, etc., for planing mill.

Ont., London—Greers Carriage Factory, York & Talbot Sts., A. B. Greer, Pres. and Gen. Mgr.—machinery for the manufacture of carriages, motor hearses, etc., to replace fire loss.

Ont., Mount Forest—L. H. Pfaff—miscellaneous tools and equipment for garage.

Ont., Mount Forest—R. Rooney—tools and equipment for garage and repair shop.

Ont., Palmerston—L. E. White, Main St. —equipment for automobile repair shop.

Ont., Port Arthur—Shuniah Lumber Co., Ltd., G. P. Stirrett, Purch. Agt.—Shimer cutter heads for flooring or V joint making, 4 bit heads and about 5 in. diameter (used).

Ont., Toronto—Dominion Wheel & Foundry, Ltd.. F. J. Neale, Vice-Pres.—locomotive or coach wheel lathe (used).

Ont., Welland — S. Lambert — complete woodworking machinery for planing mills, to replace fire loss of $50,000.

Ont., Whitechurch—J. Wilson—machinery for saw mill.

Que., Lachenaie—Z. Therrien—complete equipment for saw mill.

Que., Montreal — J. Desrosiers, 268 Christopher Columbus St.—sash and door machinery to replace that recently destroyed by fire.

Que., Montreal — O. Quintal, Ltd., 78 Pagreneau Ave.—woodworking equipment for manufacture of carriages, to replace fire loss of $100,000.

Que., Montreal — Sargent, Howard, Latourelle, Ltd., G. S. Sargent, Pointe Claire, Purch. Agt.—equipment for metal foundry.

Ont., Windsor — Universal Steel Wheel Co., Hanna St.—special equipment, presses, metal working machinery.

Opportunities for Future Business

Calif., Oakland — Fageol Motors Co., Hollywood and 107th Aves., is having plans prepared for the construction of a second unit addition to present plant. Estimated cost $17,000. Private plans.

Calif., Santa Cruz—Santa Cruz County Supervisors plan the construction of shops to repair county road equipment. L. Bowman, Co. Surveyor.

Ill., Chicago—D. S. Klafter, archt., 64 West Randolph St., taking bids for the construction of a 5 story and basement, 75 x 100 ft. garage at 925 West Kinzie St. for Kinzie Bldg. Corp., 64 West Randolph St. Noted July 10.

Ill., Sterling—Charter Gas Engine Co., will receive bids early in 1925 for the construction of a 1 story, 80 x 180 ft. superstructure for machine shop, also contemplate foundry building later. F. D. Chase, 645 North Michigan St., Chicago, Archt. and Engr.

Ind., Columbus—Dunlap & Co. plans 2 story, 60 x 150 ft. machine shop. Estimated cost $45,000. Private plans.

Ia., Waterloo — Cement Machinery Co., awarded the contract for the construction of a 1 story, 40 x 108 ft. casting storage house. Estimated cost $45,000.

Mass., Boston — J. Shapiro & Son, 27 School St., has awarded the contract for the construction of a 3 story and basement, 63,000 sq.ft. garage at 1168 Commonwealth Ave. Estimated cost $550,000.

Mass., Cambridge — J. J. Shine, 1374 Massachusetts Ave., is having plans prepared for the construction of repair shop and garage on Green St. Estimated cost $150,000. Engineer and architect not selected.

Mass., New Bedford—A. W. Jenness, 104 Elm St., awarded the contract for the construction of a 1 and 2 story, 45 x 70 ft. and 40 x 70 ft. repair shop and service garage. Estimated cost $40,000.

Mass., Somerville—Ford Motor Co., Highland Park (Detroit P. O., Mich., having plans prepared for the construction of a 1 story, 300 x 1,160 ft., assembling plant, on Middlesex Ave., here. First unit of $4,000,000 project. Private plans.

Mass., Stoughton — The Greb Co., Inc., 173 State St., Boston, is having plans prepared for the construction of a factory and machine shop. Estimated cost $40,000. Engineer and architect not selected.

Mass., Worcester — Worcester Stamped Metal Co., F. E. Billings, Mgr., has awarded the contract for the construction of a 2 story, 40 x 65 ft. plant. Estimated cost $40,000.

N. J., Elizabethport—Singer Manufacturing Co., Elizabethport, has awarded the contract for the construction of a 1 story addition to rolling mill. Estimated cost $50,000.

O., Canton—G. Rubin plans the construction of a 1 story, 50 x 200 ft. garage on Market St. Estimated cost $150,000. Stanley & Scheibel, 1301 Wick Bldg., Youngstown, Archts.

O., Cleveland — Central Brass Mfg. Co., Edgar A. Eckhouse, Pres., East 55th St., plans 3 story and basement, 63 x 122 ft. factory on East 55th St. Estimated cost $100,000. Christian, Schwarzenberg & Gaeda, 1900 Euclid Ave., Archts.

O., Euclid—Ajax Mfg. Co., (bolt and nut machinery) Homer D. Hemen, Gen. Mgr., 3830 Lakeside Ave., Cleveland, having plans completed for the construction of a 1 story, 129 x 364 ft. machine shop; 2 story, 25 x 100 ft. office; one story, 60 x 200 ft. pattern shop; one story, 60 x 60 pattern shop and 40 x 72 ft. boiler house, on Chardon Rd. Estimated cost, $350,000. Withington-Roberts-Wright Co., Swetland Bldg., Cleveland, Archts.

O., Massillon—American Drilling Machine Co. is having plans prepared for the construction of a 70 x 100 ft., factory, at Paul Farm. Estimated cost $75,000 to $100,000.

O., Massillon — Central Steel Co., Massillon, has awarded the contract for the steel work for proposed blast furnace and power plant. Estimated cost $5,000,000. Total expenditure $10,000,000.

Pa., Kennett Square — American Road Machine Co., Commercial Trust Bldg., Phila., has awarded the contract for the construction of a 1 story and basement, 132 x 158 ft. plant. Noted Nov. 27.

Pa., Phila.—H. Brinton Co., Kensington and M Sts., has awarded the contract for the construction of a 1 story and basement, addition to factory for the manufacture of knitting machinery. Estimated cost $10,000.

Pa., Phila.—H. B. Smith Co., 17th and Arch Sts., manufacturers of boilers and radiators, awarded the contract for the construction of a 1 and 2 story and basement, 86 x 200 ft. and 50 x 60 ft., office, etc., 9th St. and Grays Ave.

Pa., Phila. — E. A. Wightman, Archt., Bankers Trust Bldg., will soon award the contract for the construction of a 1 story and basement, 90 x 125 ft. factory at 68th and Woodland Sts., for Duplex Valve & Meter Co., 1112 North Boston St.

Wis., Madison—Madison Motor Car Co., c/o F. Wooton, Pres., 325 West Gorham St., having plans prepared for the construction of a 3 story, 60 x 210 ft., garage and machine shop. Estimated cost, $160,000. Private plans.

Wis., Menasha—Paper Roll Plug Co., Tayco St., is having preliminary plans prepared for the construction of a 1 and 2 story factory. Estimated cost $40,000. E. A. Wetlengel, 578 Pierce Ave., Appleton, Archt.

Wis., Milwaukee—Northern Realization Co., 1614 Fratney St., manufacturer of machinery, has awarded the contract for remodeling their factory. Estimated cost $25,000.

Ont., Galt—P. W. Gardener & Son, Harris St., has awarded the contract for the construction of a 2 story, 36 x 80 ft. machine shop.

Ont., London—Greers Carriage Factory, York & Talbot Sts., plans to rebuild plant recently destroyed by fire, with loss of $150,000.

Que., Thurso—The Singer Mfg. Co., St. John's, plans the construction of a plant.

Ont., Toronto — McLaughlin Motor Car Co., 128 Church St., awarded the contract for the construction of a 3 story garage, show room and service station, at Bay & Greenville Sts. Estimated cost $200,000.